Edited by:

ROBERT HOFMANN, WIEBKE KIRLEIS, JOHANNES MÜLLER, VITALII RUD, STANISLAV ŢERNA†, MYKHAILO VIDEIKO

From Ros to Prut:

TRANSFORMATIONS OF TRYPILLIA SETTLEMENTS

VOLUME II



SCALES OF TRANSFORMATION IN PREHISTORIC AND ARCHAIC SOCIETIES | 19.2

From Ros to Prut:

TRANSFORMATIONS OF TRYPILLIA SETTLEMENTS

VOLUME II

sidestonepress

Edited by:
ROBERT HOFMANN, WIEBKE KIRLEIS, JOHANNES MÜLLER, VITALII RUD, STANISLAV ȚERNA†, MYKHAILO VIDEIKO

From Ros to Prut:

TRANSFORMATIONS OF TRYPILLIA SETTLEMENTS

VOLUME II

SCALES OF TRANSFORMATION | 19.2

© 2025 individual authors

This book is published under a Creative Commons Attribution 4.0 International License (CC BY 4.0). This license does not apply to content that is attributed to sources other than the copyright holder mentioned above. Under this license you are free to share and adapt this work, provided the makers are attributed.

For more information about our licenses, please visit https://www.sidestone.com/publishing/creative-commons.



Published by Sidestone Press, Leiden
www.sidestone.com
E-mail: info @ sidestone.nl
Phone: (+31)(0)71-7370131

Imprint: Sidestone Press Academics
This book has been peer-reviewed. For more information see www.sidestone.com

Graphic editing: Esther Thelen and Ralf Opitz
Copy-editing: Sara Krubeck and Nicole Taylor
Language editing: Moura MacDonagh
Layout & cover design: CRC 1266/Carsten Reckweg and Sidestone Press
Cover images: Susanne Beyer

ISBN 978-94-6427-075-4 (softcover)
ISBN 978-94-6427-076-1 (hardcover)
ISBN 978-94-6427-077-8 (PDF e-book)
ISSN (print) 2590-1222 |(e-book) 2950-2438

DOI: 10.59641/kao351dm

The STPAS publications originate from or are involved with the Collaborative Research Centre 1266, which is funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation; Projektnummer 2901391021 – SFB 1266).

Contents

BUG-DNIESTER INTERFLUVE (REGION B) **7**

14. Tracing Trypillia transformations in the Southern Bug-Dniester interfluve: archaeological investigations in the Kryzhopil region, Ukraine **9**
Vitalii Rud, Robert Hofmann, Viktor Kosakivskyi, Olha Zaitseva, Johannes Müller

15. Miniature ceramic items from Trypillia settlements of South-East Podillia **129**
Natalia Burdo, Vitalii Rud, Robert Hofmann

PRUT-DNIESTER INTERFLUVE (REGION C) **155**

16. Pits as durable narratives – Results of the 2019 excavation campaign in the Trypillia settlement Stolniceni 1, Moldova **157**
Stanislav Țerna†, Andreea Țerna, Robert Hofmann, Mariana Vasilache, Marta Dal Corso, Yevhenii Sliesariev, Wiebke Kirleis, Johannes Müller

17. Putinești 3 and Trinca-*La Șanț*: archaeomagnetic investigation of middle and late Trypillia settlements in Moldova **215**
Robert Hofmann, Stanislav Țerna†, Liudmyla Shatilo, Vitalii Rud, Ghenadie Sîrbu

18. Trypillia settlements after mega-sites: Archaeological and geophysical Investigations in the Cunicea micro-region, Prut-Dniester interfluve **253**
Stanislav Țerna†, Robert Hofmann, Liudmyla Shatilo, Vitalii Rud

TRYPILLIA MACROSCALE **297**

19. Radiocarbon dating: Trypillia detailed chronology, house duration estimates and the contemporaneity of earliest European mega-sites **299**
Johannes Müller, Robert Hofmann, Wiebke Kirleis, Liudmyla Shatilo, Frank Schlütz, Mykhailo Videiko, Vitalii Rud, Stanislav Ţerna†, Andreea Ţerna

20. Ring-shaped settlement plans and Trypillia population agglomeration **375**
Robert Hofmann, Liudmyla Shatilo, Knut Rassmann, Vitalii Rud, Stanislav Ţerna†, Stefan Dreibrodt, Vladyslav Chabaniuk, Wiebke Kirleis, Johannes Müller

21. Transformations of Trypillia settlements **423**
Johannes Müller, Robert Hofmann, Wiebke Kirleis, Liudmyla Shatilo, Frank Schlütz, Marta Dal Corso, Stefan Dreibrodt, Mykhailo Videiko, Vitalii Rud, Stanislav Ţerna†, Andreea Ţerna

BUG-DNIESTER INTERFLUVE (REGION B)

14. Tracing Trypillia transformations in the Southern Bug-Dniester interfluve: archaeological investigations in the Kryzhopil region, Ukraine

Vitalii Rud, Robert Hofmann, Viktor Kosakivskyi, Olha Zaitseva, Johannes Müller

Abstract

In this chapter we present results of systematic Ukrainian-German field research on Trypillia settlements conducted between 2017 and 2019 within the currently under-investigated region in the vicinity of the modern town of Kryzhopil, Ukraine. Our study region is located in the forest-steppe zone northwest of the Black Sea, on the watershed between the Dniester and Southern Bug river systems. The paper presents results of archaeomagnetic surveys, field walking, excavations and scientific dating at ten settlements dating from 4300 to 4000 BCE (Trypillia B1–B2) and from 3600 to 3400 BCE (Trypillia C2). Our research provides important new data on many aspects of Trypillia communities, including chronology, development of settlement structures and layouts, communal buildings, pottery production and community sizes.

Introduction

Within the framework of the long-standing Ukrainian-German cooperation between the Institute of Archaeology of the National Academy of Sciences of Ukraine (IA NASU) and Christian-Albrechts-University (CAU) of Kiel (Germany), we carried out systematic archaeological field research in the Kryzhopil region in several campaigns between 2017 and 2019. This fieldwork took place within the framework of a broader interregional comparison of settlement trajectories within the Cucuteni-Trypillia (CT) network with the aim of clarifying the settlement history of a specific sub-region of CT (Chapman *et al.* 2014; Hofmann *et al.* 2018).

The test region around the town of Kryzhopil in the southern part of the forest-steppe area of the Dniester-Southern Bug interfluve was chosen to answer questions

regarding the occurrence, spread and spatial distribution of Trypilllia settlements. The first concerns the beginning of the Trypillia settlement in the mentioned region. Earlier published maps (Rud 2015b, Fig. 2; Rud 2018, Fig. 1) clearly demonstrate a significant concentration of the Trypillia B1–B2 sites in the Kryzhopil region, situated directly on the watershed of two major river basins. Before the beginning of our fieldwork, these settlements were known mainly through surface finds (Zahoruiko and Shumova 1997; Potupchyk *et al.* 1996; Rud *et al.* 2019b). Earlier published summary investigations which highlight this chronological stage of the Trypillia presented the region as an absolutely blank spot (Vinogradova 1983; Husiev 1995; Zaiets and Ryzhov 1992). Moreover, as field investigations indicated the existence of settlements larger than 20 ha (Potupchyk *et al.* 1996, 7) or even 50 ha (Rud *et al.* 2016, 12), our investigations promised to provide insights into the beginning of Trypillia population aggregation processes.

There is also a concentration of mega-sites in the southern part of the forest-steppe area of the Dniester-Southern Bug interfluve. These are located in the Southern Bug River basin and belong to the Chechelnyk group of the period Trypillia CI (Rud *et al.* 2019a). Ceramic materials produced in the Chechelnyk group tradition were also found west of Kryzhopil, at the settlement of Stina IV (Tkachuk and Jakubenko 2002–2003). No settlements of this group were found in the area between the above-mentioned settlement and the distribution of the Chechelnyk group mega-sites, over a distance of almost 70 km. Therefore, it was extremely important to determine the reason for the absence of Trypillia C1 mega-sites in the central southern part of the forest-steppe zone in the Dniester and Southern Bug interfluve. At this time the agglomeration processes in the Trypillia area reached their peak, as characterised by sites on the left bank of the Southern Bug River basin in the Sinyukha River basin. It is striking that during the period of the largest Trypillia mega-sites in the Sinyukha River basin (ca. 3950–3650 BCE) almost no settlements have been found in the Kryzhopil region. Thus, the present investigation here provided the opportunity to explore a settlement trajectory that deviated from those of the Syniukha region.

In line with these overarching objectives, our research focused in three directions: (1) systematic field walking and surface finds collection were undertaken in an attempt to obtain a more complete picture of the diachronic settlement history of this region from the Palaeolithic to the first centuries of the 2nd millennium CE; (2) the investigation of settlement plans of different periods of CT by archaeomagnetic survey in order to examine settlement layouts and identify communal buildings; (3) to study the absolute and relative dating of the Trypillia settlements. Absolute dates were obtained by radiocarbon dating; relative chronology was determined by studying ceramic collections of the region's settlements. In this paper we focus on the presentation of the magnetic plans obtained during this research, the excavation results achieved and the absolute chronology of the sites. With the exception of special pottery finds (see Chapter 15, this work, Vol. II), the publication of the archaeological materials from our excavations and field walking is still in the preparation stage and will be published in a separate work.

Progress of the fieldwork

The exploration was conducted as part of the fieldwork of the East Podillia Archaeological Expedition (EPAE) of the IA NASU and with the participation of scientists from CAU of Kiel, Vinnytsia State Pedagogical University (Ukraine) and Borys Grinchenko Kyiv University (Ukraine).

During two weeks in March 2017, we conducted magnetic surveys in the settlements Zabolotne, Ternivka, Krynychky, Vilshanka and Hariachkivka 2. Based on the results of the magnetic surveys, test excavations were conducted at the first

three above-mentioned settlements during two weeks in June. At the Vilshanka settlement and the newly discovered Soniachne settlement, cleaning of the damaged area of the cultural layer was conducted. Furthermore, we performed systematic field walking at the settlement Vilshanka.

The geophysical examinations of CT settlements in the region were continued for two weeks in April 2018. During this campaign magnetic plans were acquired for the settlements Kisnytsia, Soniachne, Hariachkivka 3, Hariachkivka 7 and Hariachkivka 8. Test excavations were conducted at the Kisnytsia settlement.

For four weeks in July 2019 the expedition camp was located in the village of Hariachkivka. Based on the magnetic plan of the settlements, test excavations were conducted at the settlements Hariachkivka 3, Hariachkivka 7 and Hariachkivka 8. During all the campaigns, systematic field walking survey over the territory of the region was performed.

Methods

Measurements

The local topographical survey of the excavation areas was conducted with a Leica DGPS (GNSS Viva). Our measurements used the world coordinate system with a precision of several centimeters. In order to ensure the possibility of reconstructing the measurement system, fixed points were established and documented. The measurements themselves were performed in the UTM coordinate system (zone 35N) and WGS 84 ellipsoid. Due to the ellipsoid used, all elevation data require correction by approximately -30 m.

Magnetic survey

The archaeomagntic surveys were performed using a SENSYS MAGNETO® MX V3 Survey System of SENSYS Sensorik & Systemtechnologie GmbH Bad Saarow, Germany. The device was used with eight sensors which were installed at intervals of 0.5 m on a wheeled cart pushed by two persons. The geomagnetic device was coupled with a GPS-system (Leica, GNSS/GPS systems Viva GS 10) enabling continuous grid measurements (zig-zag) in a small amount of time.

Data acquisition, primary data processing, interpolation and export were performed using the SENSYS software package MonMX (v. 4.0), DLMGPS (v. 4.01) and MAGNETO®- ARCH (v. 3.0). During export from DLMGPS the automatic track offset correction was turned on. For data export from MAGNETO ARCH we choose the format Surfer grid 7 which deliver raster maps which can be used in GIS applications which enables the modification of thresholds and color scale. The standard setting was used which interpolates the measurement results to 0.2 m x 0.2 m raster cells.

Excavations

During the excavations, we applied a traditional methodology for Trypillia field investigations; earth removal was carried out in artificial layers (spits), each corresponding to circa 20 cm soil depth, on quadrats of 1 m^2. In addition, after contouring the Copper Age features the excavation was done in both artificial and ‘natural’ layers, following the specifics of the archaeological features. In most cases after reaching sterile soil outside the pit, it was left untouched and the pit contents (refill layers) were excavated negatively in the same 20-cm spits down to the bottom. For the documentation of horizontal planas and vertical

profiles, digital photogrammetry has been used. The exact position was measured for all the single finds and samples. The finds from the excavations and surface collections are held in the State Historical and Cultural Reserve 'Trypillia Culture' (Lehedzyne) and in Vinnytsia Regional Museum of Local History, Ukraine. From each of our test trenches in the surveyed sites, we obtained a small number of samples for archaeobotanical studies, which are published elsewhere as part of a larger Trypillia dataset (Kirleis *et al.* 2024).

^{14}C dating

Calibrations of individual datings were carried out as 'R-date' with the software OxCal 4.4 using the calibration curve IntCal20 (Reimer *et al.* 2020). Where several dates or sequences with stratigraphic information were available from one context, Bayesian modelling was carried out using the boundary function (Bronk Ramsey 2009).

Geography

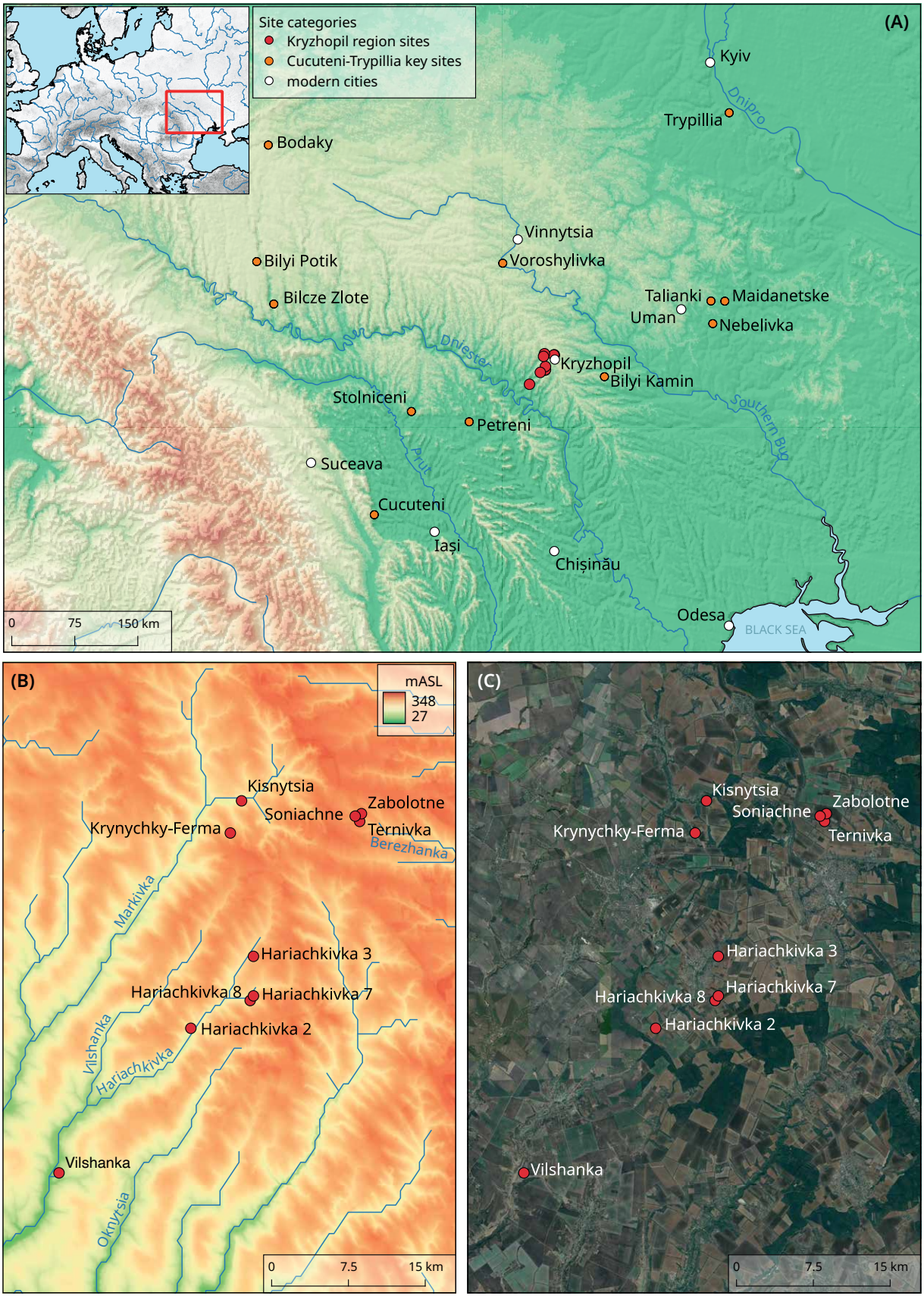
Magnetic survey and excavations were conducted at ten settlements in the region around the modern city of Kryzhopil in the Vinnytsia Oblast of Ukraine (Fig. 1). The distance between the southernmost settlement Vilshanka and the northernmost settlement Kisnytsia is a little more than 26 km, along a northeast-southwest line. The general area over which the various field investigations were carried out has a diameter of about 40 km. The geographic centre of the study region is approximately the village of Hariachkivka. At the time of the investigations, according to the administrative and territorial division, all settlements belonged to the Kryzhopil Raion. Since 2020, after an administrative reform, the sites belong to the Kryzhopil and Horodkivka territorial communities of the Tulchyn Raion. The Moldova-Ukraine border runs 12 km to the south of the southernmost Trypillia culture settlement of the region.

The region around the modern city of Kryzhopil is located in the southeastern part of the Podillia Upland, which is part of the East European Plain. According to the physical and geographical zoning, the region is located in the southern part of the modern forest-steppe zone. From a hydrographic point of view, it is located at the watershed of two large rivers of the Northern Black Sea basin, the Dniester and Southern Bug. The southwestern part of the region is located in the southern part of the Middle Dniester River basin. The investigated Trypillia settlements are located in the basin of the left tributary of the Dniester – the Markivka River. The largest inflow of the Markivka River is the Vilshanka River. Our research covers the upper and middle basins of these two rivers.

The northeastern part of the region is located in the middle course of the Southern Bug River. The Eneolithic settlements that were investigated here are located in the upper reaches (Berezhanka River) of the Dokhna River basin – the right tributary of the Southern Bug River.

There is a difference in the morphology of river valleys. The Southern Bug basin is characterised by shallow valleys, with gentle slopes and wide bottoms. By contrast, in the Dniester basin, the floodplains are deeply incised, canyon-like, narrow or absent (Denysyk 1998, 33, 35). There is also a difference in the geological structure of the basins of these two large rivers. Thick loess deposits are widespread in the Southern Bug basin, whereas in the Dniester basin limestones and sandstones along with loess deposits are presented (Denysyk 1998, 28–32). The central and northern parts of the region are covered by Podzol soils (Chernozem, dark grey and light grey). The southern part of the region is covered by Chernozem with a very weak humus supply. In the central part of the region there is a small zone with regraded Chernozem (Dedov 2002; Denysyk 1998, 36–38). The Vilshanka settlement is located

Figure 1 (opposite page). Location of the investigated sites of the Kryzhopil region within a map of Cucuteni-Trypillia key settlements (A); location of the investigated sites on the topographic map (B) and the Google satellite image (C). Data on water resources are from www.hydrosheds.org.


(A)
Site categories
Kryzhopil region sites
Cucuteni-Trypillia key sites
modern cities
Kyiv
Dnipro
Trypillia
Bodaky
Vinnytsia
Voroshylivka
Bilyi Potik
Bilcze Zlote
Talianki
Maidanetske
Uman
Nebelivka
Dniester
Kryzhopil
Bilyi Kamin
Stolniceni
Petreni
Southern Bug
Prut
Suceava
Cucuteni
Iași
Chișinău
Odesa
BLACK SEA
0 75 150 km
(B)
mASL
348
27
Kisnytsia
Soniachne
Zabolotne
Krynychky-Ferma
Ternivka
Berezhanka
Markivka
Hariachkivka 3
Hariachkivka 8
Hariachkivka 7
Hariachkivka 2
Vilshanka
Hariachkivka
Oknyrsia
0 7.5 15 km
(C)
Kisnytsia
Soniachne
Zabolotne
Krynychky-Ferma
Ternivka
Hariachkivka 3
Hariachkivka 8
Hariachkivka 7
Hariachkivka 2
Vilshanka
0 7.5 15 km

in the distribution area of the Chernozem with very weak humus supply, while the rest of the investigated settlements are associated with the area of distribution of Podzol Chernozems and dark grey soils.

Results

The settlement complex of Zabolotne-Ternivka-Soniachne

Research history

The settlement complex consists of three settlements, Zabolotne, Ternivka and Soniachne, which are concentrated on a small area less than 200 meters apart (Fig. 2).

The Ternivka settlement was discovered in 1996 during field walking of the archaeological expedition of the Vinnytsia Regional Museum of Local History led by M. V. Potupchyk (Potupchyk *et al.* 1996, 7). The archaeological field surveys were carried out in preparation for the construction of the NPK 'Pivdenny' oil pipeline, with the aim of identifying areas requiring protection in terms of heritage conservation (Levada 1996, 17–18). A second archaeological investigation of the settlement was conducted as part of the EPAE in 2015 (Rud *et al.* 2016, 10). During this survey the Zabolotne settlement was discovered. The number of collected artefacts was small. From this survey, the spatial distribution of artefact scattering on the surface was clarified for the first time.

In spring 2017, a geomagnetic survey of the Zabolotne and the Ternivka settlements was conducted in a joint cooperation between CAU and IA NASU. In summer 2017, test excavations of anomalies of building and pit were performed. During these excavations, the promontory on the north-west of the Ternivka site was investigated and Trypillia culture artefacts were found as well. The new site was given the name of Soniachne. On the edge of the field the damaged part of the cultural layer was investigated. In spring 2018 the magnetic survey of Soniachne settlement was performed.

Geographical position

The settlement complex under discussion here is located in the Kryzhopil territorial community of the Tulchyn Raion, 1.3 km southwest of the edge of Zabolotne modern village. The closest modern villages are Ternivka, 1.7 km to the south, and Soniachne, 2 km to the south-west. Hydrologically the settlements are located at the upper reaches of the Berezhanka River which 28 km to the east flows into the Berladynka River – a left tributary of the Dohna River. The Dohna River is a right tributary of the Southern Bug River basin, which drains to the Black Sea.

The settlement of Zabolotne (48°25'18.20"N, 28°51'53.62"E) is situated on the southern slope of a ridge formed by the almost parallel-flowing Berezhanka River and its left tributary – a small stream (Fig. 3). In other words, it stays near the left bank of that river. Due to the large area of the settlement, the buildings are located both on the slopes of the promontory with a south-west exposition going down to the river and on the flat surface on top of the promontory. The whole area of the settlement is free from modern buildings, trees or roads.

The Ternivka settlement (48°25'2.92"N, 28°51'41.67"E) is located on the opposite, right bank of the Berezhanka River, to the south of the settlement Zabolotne (Fig. 4). The river borders the settlement from north and north-west. It is located on the



Figure 2. Zabolotne, Ternivka, Soniachne: general magnetic plan of the sites against the background of the Google satellite image.





slightly inclined edge of the plateau on the north and north-east aspect of the slope. The western part of the settlement area is occupied by young forest; a break caused by wind goes through the trees in the southern part. The field road alongside the forest has also damaged three wood-clay buildings ('ploshchadka'), oriented east-west. Two of these were recorded by the archaeomagnetic survey.

The Soniachne settlement (48°25'13.97"N, 28°51'33.99"E) is located on the left bank of the Berezhanka River, as at Zabolotne (Fig. 5). Naturally speaking, these two settlements are divided by now-dry streambeds which join the river on the left side, creating a form of promontory. The settlement is situated on the north-east side of this promontory. The surfaces of the promontory have mostly north-east expositions. Part of the promontory is destroyed over an area of approximately 0.25 ha by the Chernozem extraction alongside the streambed. Archaeological sites could potentially be located here.

Figure 3 (opposite page, above). Zabolotne, view of the site from the south. Light spots on the field are damage from ploughing wood-clay buildings. Photo taken during magnetic survey of the site in March 2017.

Figure 4 (opposite page, below). View of the Ternivka site (in the background of the photo). The foreground shows a test excavation at the Zabolotne site carried out in June 2017.

Zabolotne

Magnetic survey

The archaeomagnetic survey of the Zabolotne settlement was performed over an area of 34.7 ha (Fig. 6). Anomalies of archaeological features were found over an area of 30 ha. The survey covered the majority of the settlement; the eastern and central parts of the site were prospected. Two areas of approximately 5 ha in size each on the north-west and south-west sides of the settlement lie outside the scanned territory. Considering the distribution of the anomalies present, the total area of the Zabolotne settlement is estimated to be 40 ha.

Geomagnetic anomalies of the Zabolotne settlement can be divided into the following categories:

Figure 5. Soniachne, view of the site from the north-east, from the western part of the Zabolotne site. The location of Profile 1 at the Soniachne site is indicated on the photograph.



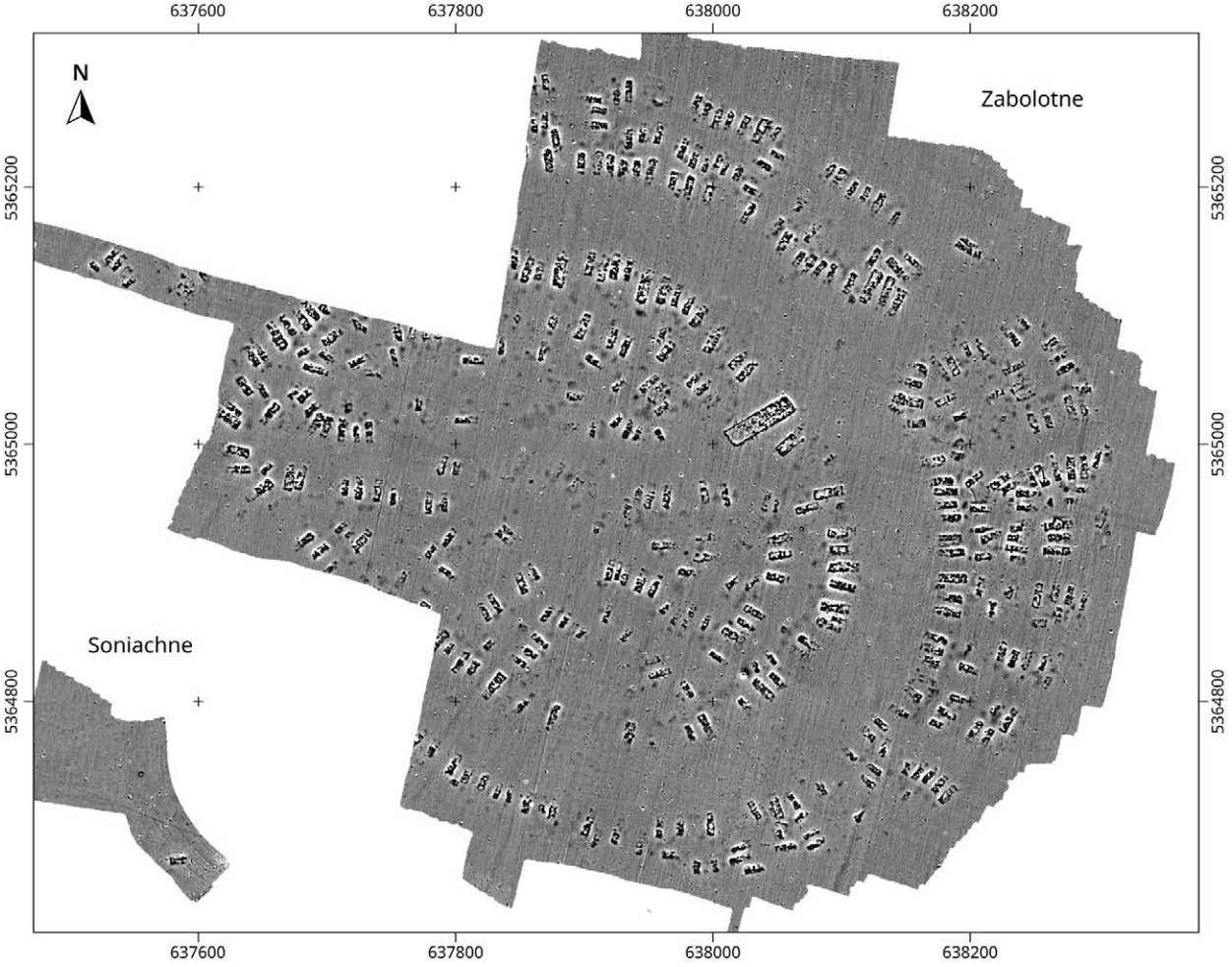


Figure 6. Zabolotne, Soniachne: magnetic plan of the sites.

- 372 rectangular anomalies, which are ruins of burnt wood-clay buildings.
- 22 rectangular anomalies of buildings, burnt with less intensity or eroded.
- 2 rectangular anomalies of unique buildings, so-called 'mega-structures'.
- 322 anomalies of pits of different shapes.
- 5 round anomalies, presumed to be kilns.

The settlement plan comprises the remains of burnt rectangular wood-clay buildings and associated smaller anomalies of backfilled pits. The main components of the settlement plan are two concentric building rows, oriented WNW-ESE. The size of the inner row is 520 × 340 m, the outer 650 × 480 m. The 50–80 m wide ring-corridor between the rows is free of archaeological anomalies (Fig. 7).

The buildings on the north parts of both concentric rows are located very close to each other, only 2–10 m apart. In the southern part, the distance between the buildings is larger. At many points it is 20–30 m, while at some it reaches 50 m. At the north-east part of the outer row there is a gap (site entrance) 36–60 m wide, which, like the ring-corridor, is free of buildings. The row is not interrupted to the south of the site entrance; it slowly transforms into a radial row of houses which runs in a north-east direction from the row. To the north from the site entrance the line of buildings is interrupted. However, the site entrance is delimited on the north side by three buildings, situated perpendicular to the buildings of the concentric row.

The anomalies of buildings are located outside the outer concentric row, a maximum of 125 m away from it. The largest number are located in the northern and eastern parts of the settlement. Going south their number outside the row

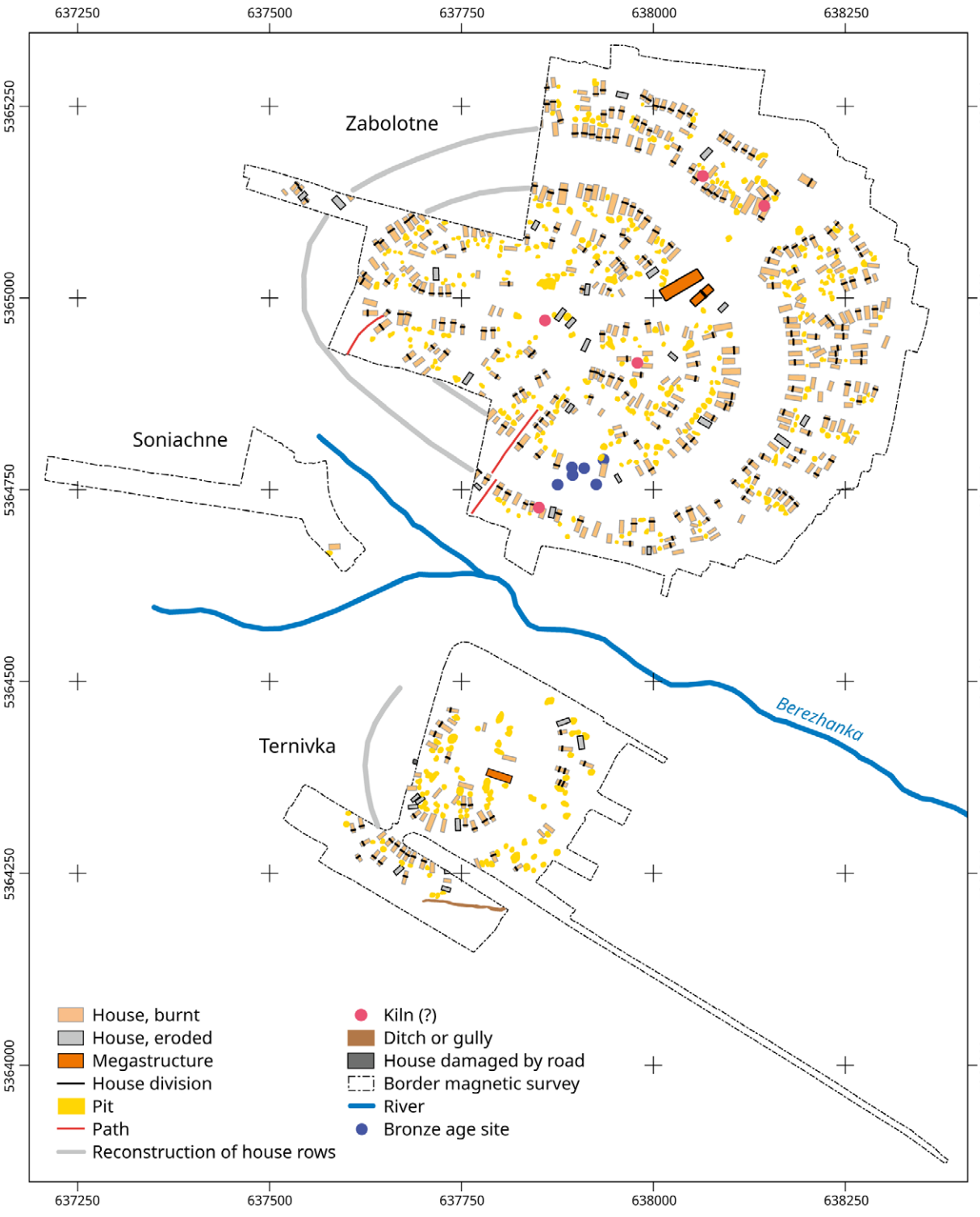


Figure 7. Zabolotne, Ternivka, Soniachne: interpretation of magnetic anomalies.

decreases. In the southern and south-western parts of the settlement they are completely absent. Such absence as well as the low density of buildings located at the southern part of the concentric rows is explained by the increasing angle of the slope in a southerly direction.

The buildings outside the outer concentric rows are joined in straight radial lines of a maximum of nine buildings at a time. The location of the lines is parallel or perpendicular (radial) relative to houses in the rows. In the same way, straight

lines of buildings are also joined in groups, between which narrow radial corridors (12–29 m wide) are free of features. Groups are easy to locate in the northern and north-eastern parts of the settlement, where the density of buildings is highest.

Buildings are also found at the central part of the settlement, inside the inner concentric row. Generally, they are set in radial straight lines or parallel to the concentric row. The concentration of these buildings is low, as is the density of the buildings outside the outer row in the south-eastern part of the settlement.

It is important to note that the rectangular anomalies of most of the first-category buildings in Zabolotne reflect a specific spatial division. They consist of two parts along the length of the building (Fig. 8). The first part is a square-shaped anomaly, which varies from 17–48% of the houses' lengths. The second part, a rectangular-form anomaly, occupies the rest of the house length. The pits are mostly located at the end of the second mentioned part, which (judging by the examples from other CT settlements) allows the determination of where the entrance to the building was located. Thus, such two parts building anomalies provide an opportunity for preliminary conclusions about internal divisions of buildings in the Zabolotne settlement. Where a house divides into two parts, the first part is the entrance area, which is approximately 1/3rd of the building and second part, the main room, which is about 2/3rd of the building. Due to the weakness of the entrance part anomalies, we assume that they, just as was the case with second-category buildings (eroded or burnt with less intensity), may have been built according to different architectural principles, for instance, using a smaller amount of clay. The confirmation or refutation of our ideas would be possible only after excavation of these buildings.

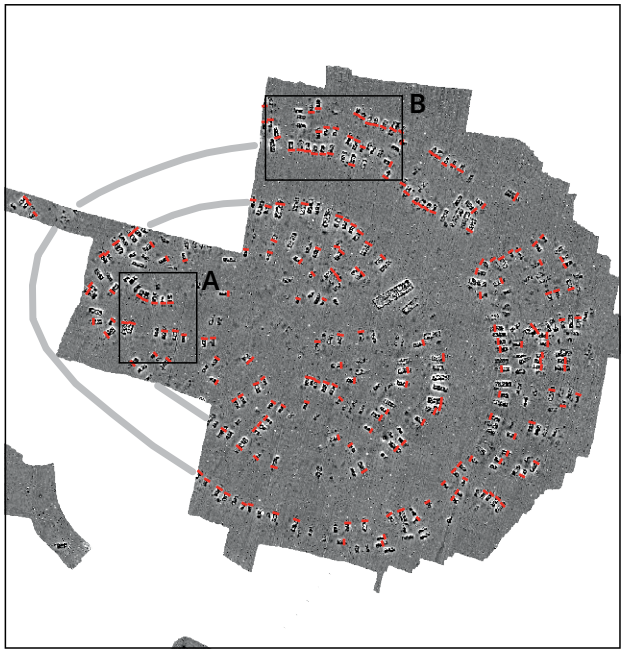
The buildings, which are considered to have been destroyed by some degree of burning or erosion, are spread all over the settlement. They can be found inside both concentric rows, in the radial straight lines of buildings outside the outer concentric row and in the centre of the settlement as well. Considering their unspecific localisation, it is possible that they were built using only small amounts of clay.

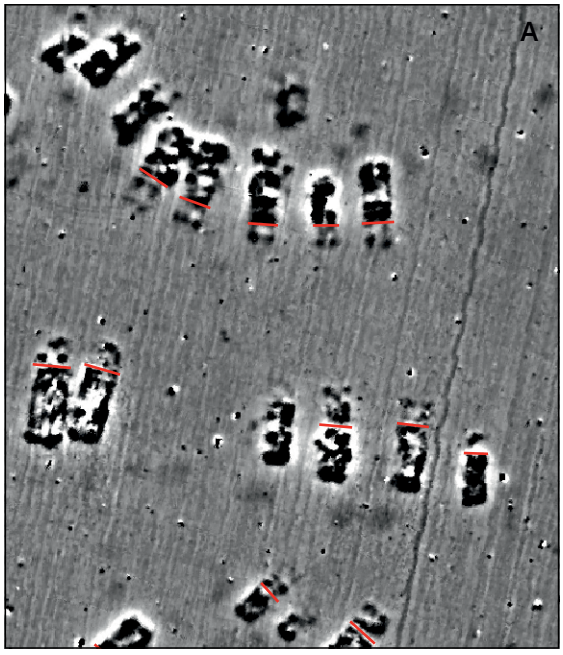
Areas of anomalies interpreted as buildings range from 29 to 283 m^2. Of the observed patterns in the location of houses grouped by area in increments of 50 m^2 (Tab. 1), the following was observed. There are no buildings with an area of less than 50 m^2 within the rows arranged along the ring-corridor (Fig. 9). They are located in the central part of the settlement and outside the outer concentric row. Buildings with an area of more than 150 m^2, on the contrary, are mainly part of the concentric rows. They have access to the ring corridor, or access to the site entrance. Buildings of this category are concentrated mainly in the northeastern part of the settlement. The most common are buildings with an area of 51–100 m^2, scattered throughout the settlement; these represent 61% of the buildings.

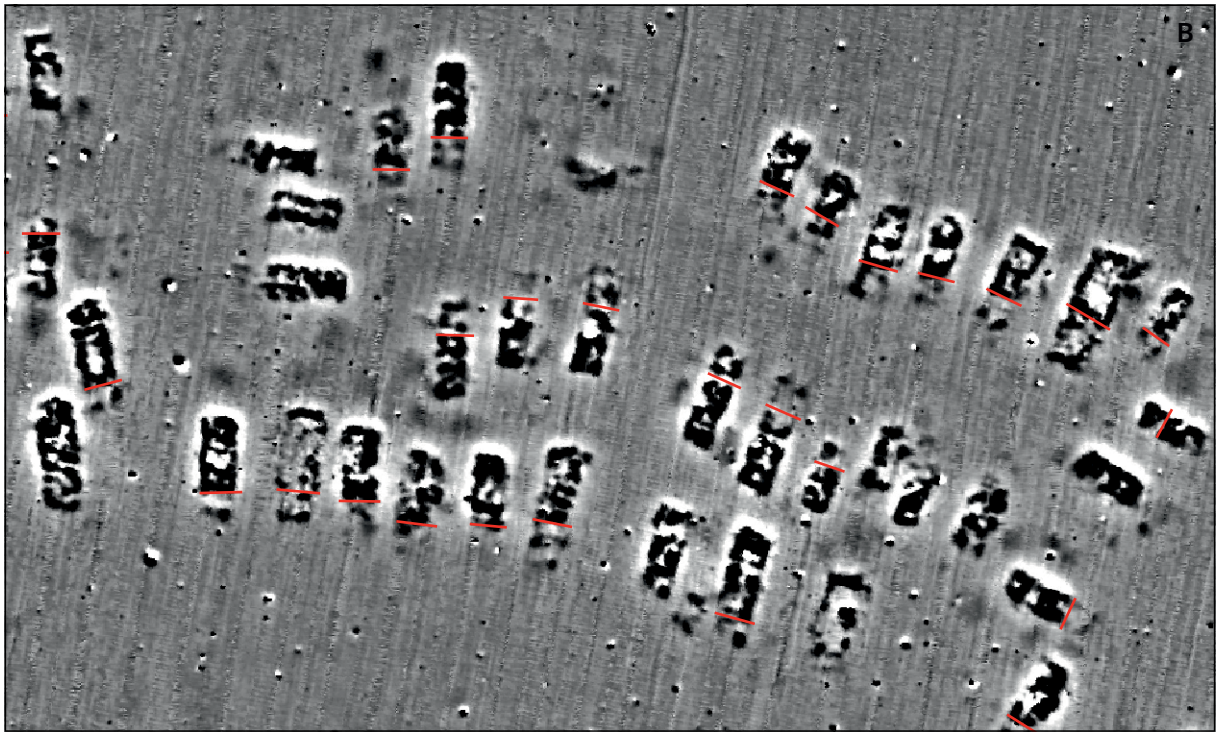
Beside of the above-mentioned buildings, two so-called 'mega-structures' (Fig. 10) were discovered in the settlement located 10–15 m apart in the north-eastern part of the inner concentric row, almost parallel to each other. They are located right opposite the site entrance in the outer row.

Mega-structure 1 measures 855 m^2 (57 × 15 m) and is the largest building in Zabolotne. Its long axis is located with an azimuth of 60°. The south-western part of the building is very damaged by agricultural activity, as can be confirmed by the large amount of daub on the surface, discovered during the surface survey of the settlement. As a result, the geomagnetic anomaly in this area is seen only as clear contours of the building.

Mega-structure 2 is located to the south-east of the first one. It is much smaller, 317 m^2 (31.7 × 10 m), which makes it more like the other large buildings at the settlement. However, its close location to Mega-structure 1, as well as its position, separated from the nearest buildings of the inner circle row, allows us to consider Mega-structure 2 to be one of the exceptional buildings within the settlement. However, we recorded a clear strong anomaly of this building over only an area of 19 × 10 m; the north-eastern part of the anomaly of the building is weak. It appears







Area (m²)	Number of buildings	Percentage of buildings (%)
29–50	42	11.00
51–100	233	61.00
101–150	86	22.51
151–200	16	4.19
201–250	4	1.04
283	1	0.26
29–283	**382**	**100**

Figure 8 (above). Zabolotne: details of the magnetic map, showing the possible division of houses into two parts.

Table 1. Zabolotne: number and percentage of buildings at the settlement, grouped by area in steps of 50 m².



Figure 9. Zabolotne, Ternivka, Soniachne: distribution of house sizes.

that the situation with the building being divided into two room repeats itself here, as was mentioned above in the description of the first-category building anomalies. The long axis of the structure is located with an azimuth of 50°.

Almost all pits in Zabolotne are located near the buildings, including those near the mega-structures. The majority are located 2–5 m away from the building-ends, presumably opposite the entrances to the buildings. A smaller number are located near the sides of the buildings. A few pits are not connected to buildings and are

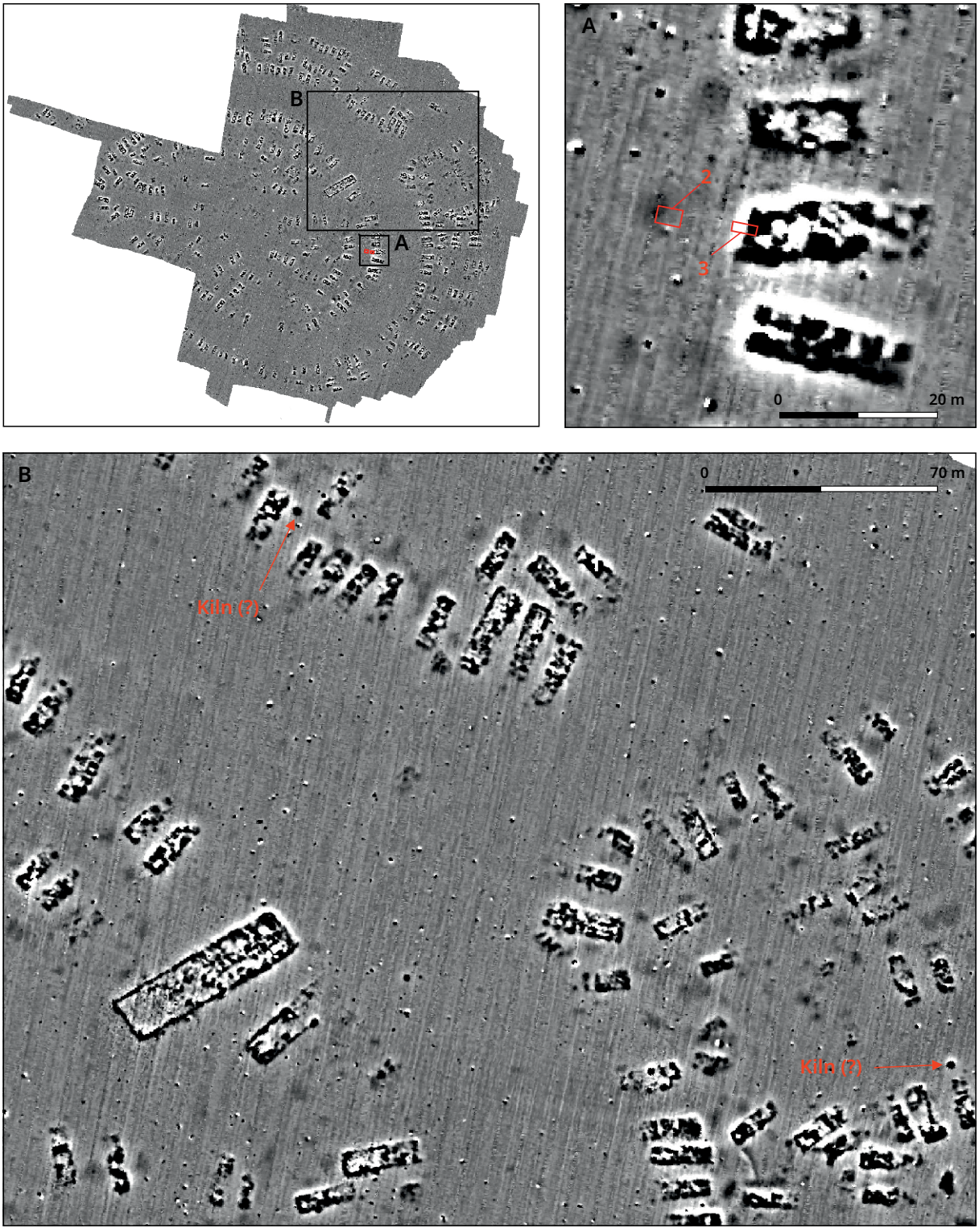


Figure 10. Zabolotne, details of the magnetic map and their locations within the settlement: (A) eastern part of the inner concentric row of houses with Trenches 2 and 3; (B) two mega-structures on the `square' (`plaza') positioned opposite the site entrance in the outer concentric row of the houses, and round features - possible kilns.

located in the centre of the settlement. The diameters of the smallest pits are 2.7–3 m; the majority of the pits are 4–7 m in diameter. The biggest pit is 24 × 14 m.

Five round anomalies 2–3 m in diameter have been recorded in different parts of the settlement, which may also be archaeological features, such as pits. However, the value of the magnetic flux density of these anomalies is 20–35 nT, *i.e.* they could potentially be kilns (Fig. 10).

Excavations

In 2017 Trenches 2 and 3 were located on the features of the inner concentric row in the eastern part of the settlement (Fig. 10). The trenches are located in the slightly sloping area, 6.7 m apart from each other. The level of the modern surface is approximately 10 cm lower in Trench 2 than in Trench 3.

Trench 2, pit

Trench 2 measures 2 × 3 m and is located in the south-west sector of the pit anomaly. The anomaly is 7.0 x 5.0 m in size, has an oval shape and is elongated in an approximately north-south direction (Fig. 10). The trench opened only the south-west section of the anomaly. The anomaly is situated 8.0 m west of the western edge of the building anomaly. Part of the building is covered by Trench 3.

A quarter of the pit was investigated in Trench 2 (Figs. 11, 12). The deepest part of it was found at 303.42 m asl. It seems that in the Eneolithic Age the depth of the pit was approximately 1.8 m. The walls of the pit are slightly sloped and the bottom is almost flat (Figs. 13, 14). The deepest natural layer is light-yellow (loess, 2006b[1]) and starts at 304.30 m asl within the trench. Above it, the yellow-black layer of loam (2006a) is 1.00–1.20 m thick. All of this is covered by the Chernozem layer (2001, 2002), 0.68–0.90 m thick.

Three archaeological contexts (2007, 2008a, 2008b) seem be anthropogenic in origin. Contexts 2008a, 2008b are filled with grey-yellow soil. The difference is in the presence of small fragments of charcoal and layers of ash in the upper layer, 2008a. In small amounts, big fragments of ceramics and burnt clay are found in both contexts, as well as fragments of animal bones and flint tools.

The area above Context 2008a is filled with layers of black-grey soil. They contain different amounts of artefacts, mostly burnt clay crumb and small fragments of ceramics. Their number is small in the upper contexts (2003, 2005). The biggest quantity, daub crumb, is found in the lowest context described, 2007. This Context 2007 also includes flint tools and animal bones. A large amount of flint flakes is found in Contexts 2007 and 2008a. The filling of the pit's upper part (2003, 2005) indicates its natural origin.

It appears that the pit was dug in order to retrieve one of the main building materials, loam (clay). Later it was used for dumping of waste, which occupied the lower part of the pit. The upper part of the pit became covered as a result of natural erosion processes.

Trench 3, wood-clay building

A test trench, 3 × 1 m, was located within the western edge of the building anomaly in the inner circle of the settlement buildings (Fig. 10). This house anomaly has a rectangular form 24.4 x 7.9 m (≈193 m^2) in size. The long axis of the anomaly is located in an almost latitudinal direction (azimuth is 88°). The pit is located to the west of the edge of the building. A quarter of the pit was examined in Trench 2. Trench 3 aimed to examine the edge of the building and the area behind it; this was completed.

---

1 After the documentation of profiles, soil samples and some other materials were taken using these context numbers: 2009 (=2001+2002), 2010 (=2004), 2011 (=2006a), 2012 (=2003+2005), 2013 (=2007), 2014 (=2008a), 2015 (=2008b).

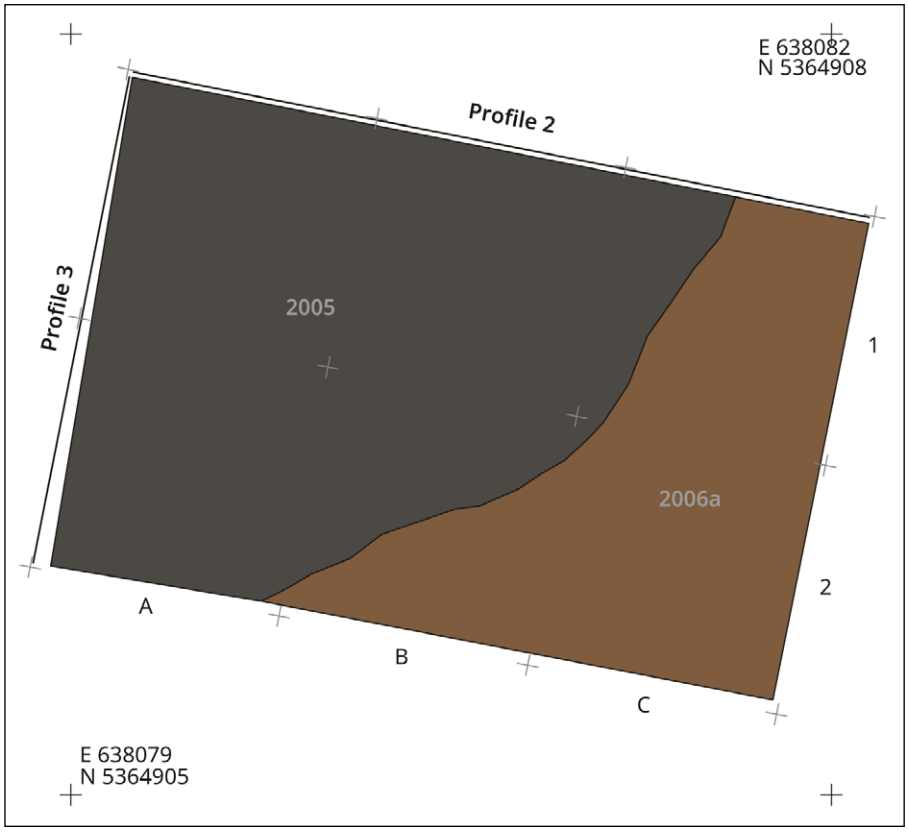


Figure 11. Zabolotne, Trench 2: the border of the pit (2005) at the level of Planum 3 (305.05–305.18 m asl). Location of Profiles 2 and 3.

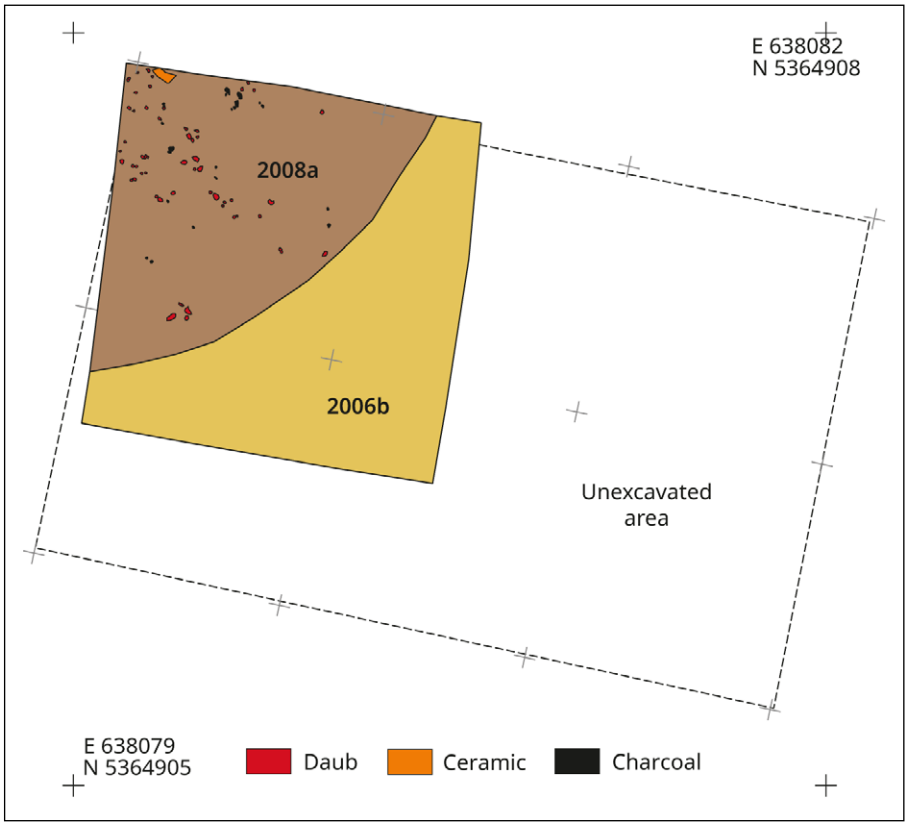


Figure 12. Zabolotne, Trench 2: the border and the filling of the pit (2008a) at the level of Planum 9 (304.15–304.22 m asl).

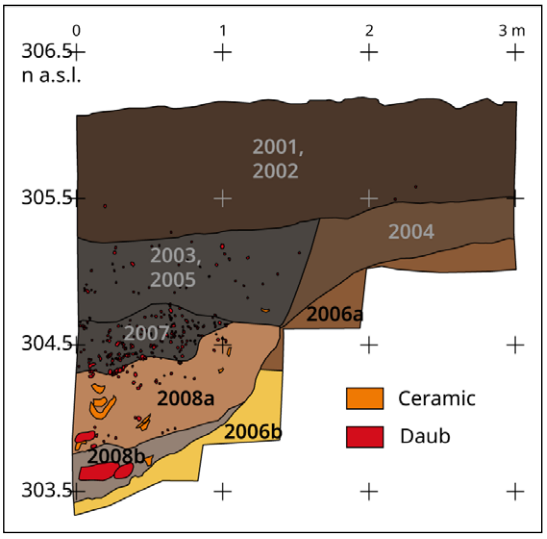


Figure 13. Zabolotne, Trench 2, Profile 2: 2001, 2002 – Chernozem; 2003, 2005, 2007 – black-grey; 2004 – black-grey, yellowish; 2006a – yellow-black; 2006b – light yellow; 2008a – brown-yellow, ash; 2008b – brown-yellow.



Figure 14. Zabolotne, Trench 2: photo of Profiles 2 (right) and 3 (left) displaying the lower part of the pit filling.

The ruins of a wood-clay building were found in the eastern part of the trench (Figs. 15–17). They were covered by the Chernozem layer (3001), 27–44 cm thick (Fig. 18). Two sequential stratigraphic layers of daub make up the building. The upper layer (3004) is made of small fragments of daub, most of which have sides that measure 7 cm. Some fragments are larger, with sides of 13–18 cm. The fragments are 2–7 cm thick. Most of the fragments are amorphous. A small number have one or two smooth sides. Some fragments have wood imprints – 3–5 cm wide split wood, log wood 1.5–2 cm in diameter. No system in the location of the wooden constructions was identified.

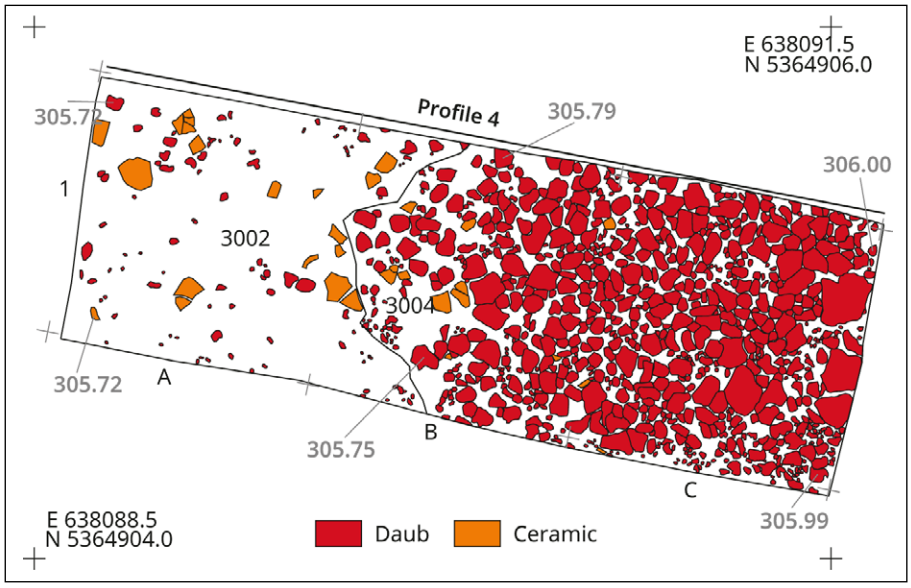


Figure 15. Zabolotne, Trench 3: Planum 1 displaying the upper daub layer of the structure. Location of Profile 4.

In contrast to Layer 3004, Layer 3005 (platform) consisted of mostly massive daub fragments, with sides up to 20 cm in size. The thickness of the fragments is 10–13 cm. They are smooth on top; the bottom has imprints of split wood 7–15 cm wide. The imprints are oriented north-south -perpendicular to the long axis of the building. The fragments of daub of both contexts have the admixture of chaff. Their colour after firing is yellow-grey, brown-red.

Below the ruins of the building is the layer of yellow-black loam (3006) with separate fragments of ceramics and bones less than 5 cm big, charcoal and daub crumbs. Different-size fragments of daub in large amounts were found in the area near the building — Context 3002, which generally marks the ancient horizon at a level of 305.8 m asl. The same materials as in Context 3006 were found here, excluding the charcoal. The filling of Contexts 3002, 3004 and 3006 included a large amount of flint flakes.

To summarise, part of the wood-clay building was examined in Trench 3. Its two-layer ruined location indicates a two-storey construction. The floor of the upper storey consisted of massive wooden details, which were perpendicular to the long axis of the building with the clay layer above. No other architectural specifics were found at the examined area. In the area behind the building separate fragments of artefacts were found. They appear to be the waste located on the ancient horizon. Those which were located in the central part of the trench were covered by the layer of daub 3004. This means that part of the daub fell to the outside at 1 m during the building's collapse.

^{14}C dating

A total of seven ^{14}C dates were obtained from cattle bones recovered in Trenches 2 and 3 in Zabolotne, three of which were double dates of the same bone in the Poznan and Kiel laboratories (Suppl. 1 in Chapter 19, this work, Vol. II). Six dates originate from different backfill layers of the pit in Trench 2. From the building investigated in Trench 3, only one date was successful, which originates from the waste area in the vicinity of the house (Poz-97918). This dating falls into the time span between 3651–3533 BCE (68.2%), respectively 3704–3526 BCE (96.4%), and is thus significantly younger than the other dating, showing a median of 3611 BCE (Fig. 19).



Figure 16. Zabolotne, Trench 3: photo of Planum 1 displaying the upper daub layer (3004) of the structure and the artefacts outside the structure. View from the west.

A Bayesian model of six dates from three successive layers of pit backfill in Trench 2 results in very low probabilities of A_{model}=18.8 and $A_{overall}$=30, respectively, because of the outlier KIA-52650. Excluding this date increases the probability of the model. Accordingly, the backfilling of the pit took place with the highest probability over a longer period between 4230 and 4020 BCE which might be, however due to the plateau-character of the calibration curve in this period (Tab. 2; Fig. 20).

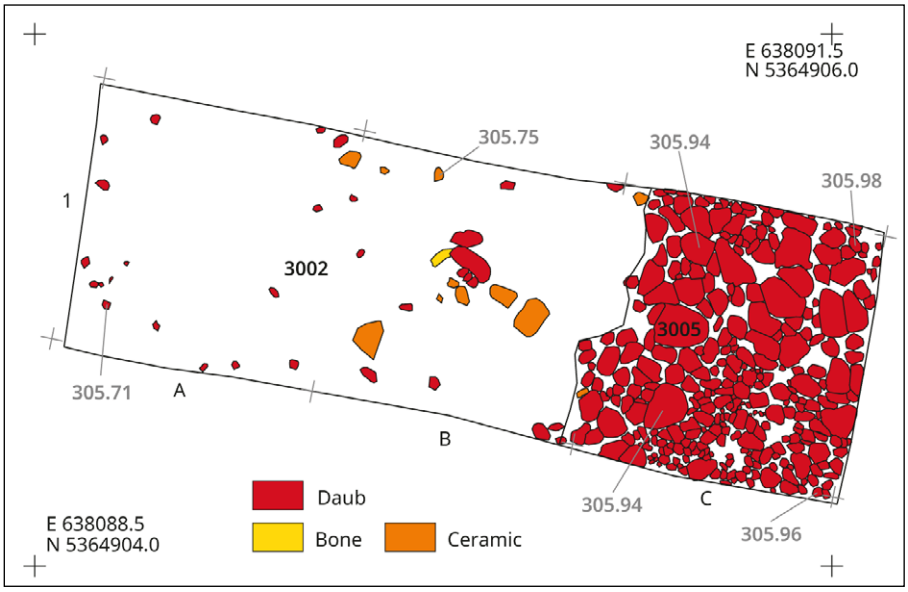


Figure 17. Zabolotne, Trench 3: Planum 2 displaying the lower daub layer (platform, 3005) of the structure.

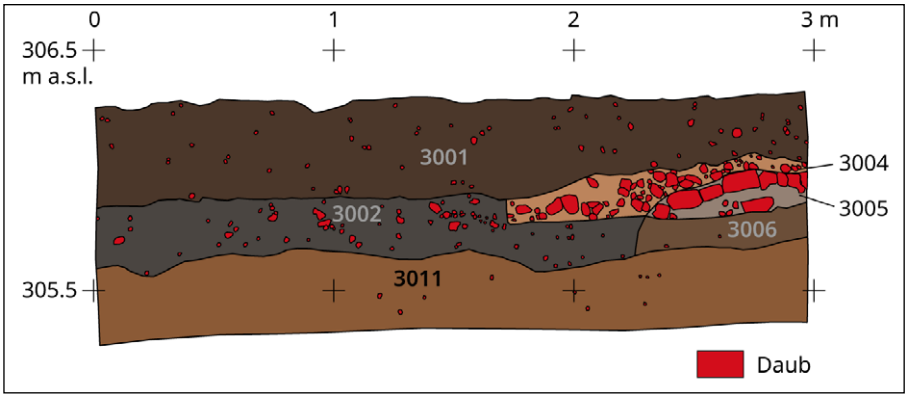


Figure 18. Zabolotne, Trench 3: Profile 4 displaying the stratigraphy of the structure and the position of the artefacts outside the structure; 3001 – Chernozem; 3002 – black-yellow; 3004 – upper daub layer; 3005 – lower daub layer; 3006, 3011 – yellow-black.

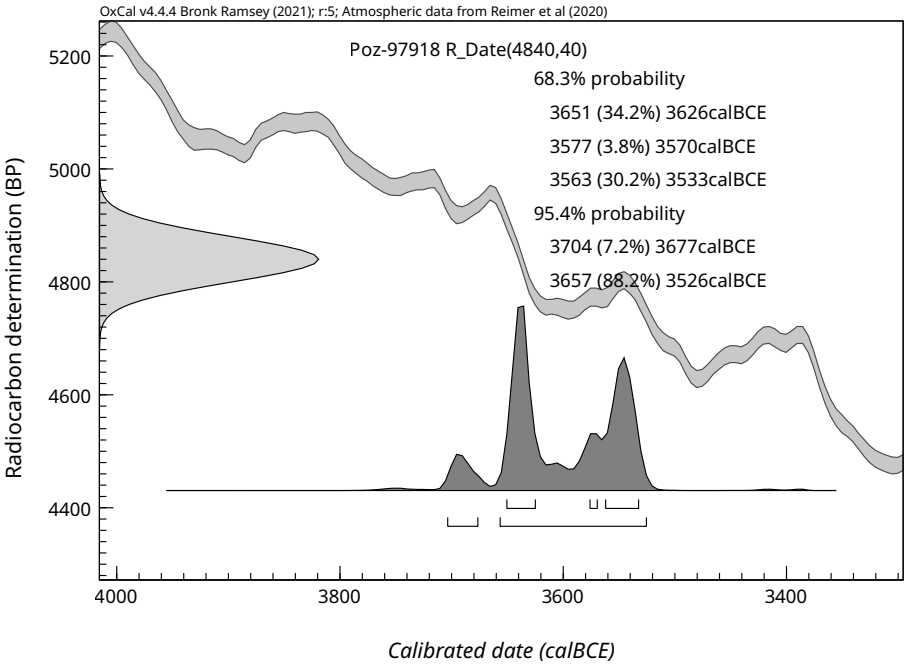


Figure 19. Zabolotne, Trench 3: calibration plot of the date Poz-97918.

	Dating range 68.2%	Dating range 95.4%	Median	Highest dating probability
Boundary start pit backfill	4265–4118	4343–4061	4207	4230
Duration	0–68	0–195	35	30 or 100
Boundary lower-middle backfill	4219–4102	4230–4067	4150	4200 or 4130
Duration	0–39	0–98	20	15 or 85
Boundary middle-upper backfill	4166–4058	4217–4051	4115	4115
Duration	0–61	0–182	30	30
Boundary end	4147–4021	4223–3931	4070	4020

Table 2. Zabolotne: Bayesian model of the backfilling process of the pit investigated in Trench 2. A_{model}=63 and $A_{overall}$=64.8. All boundary dates BCE, durations in years.

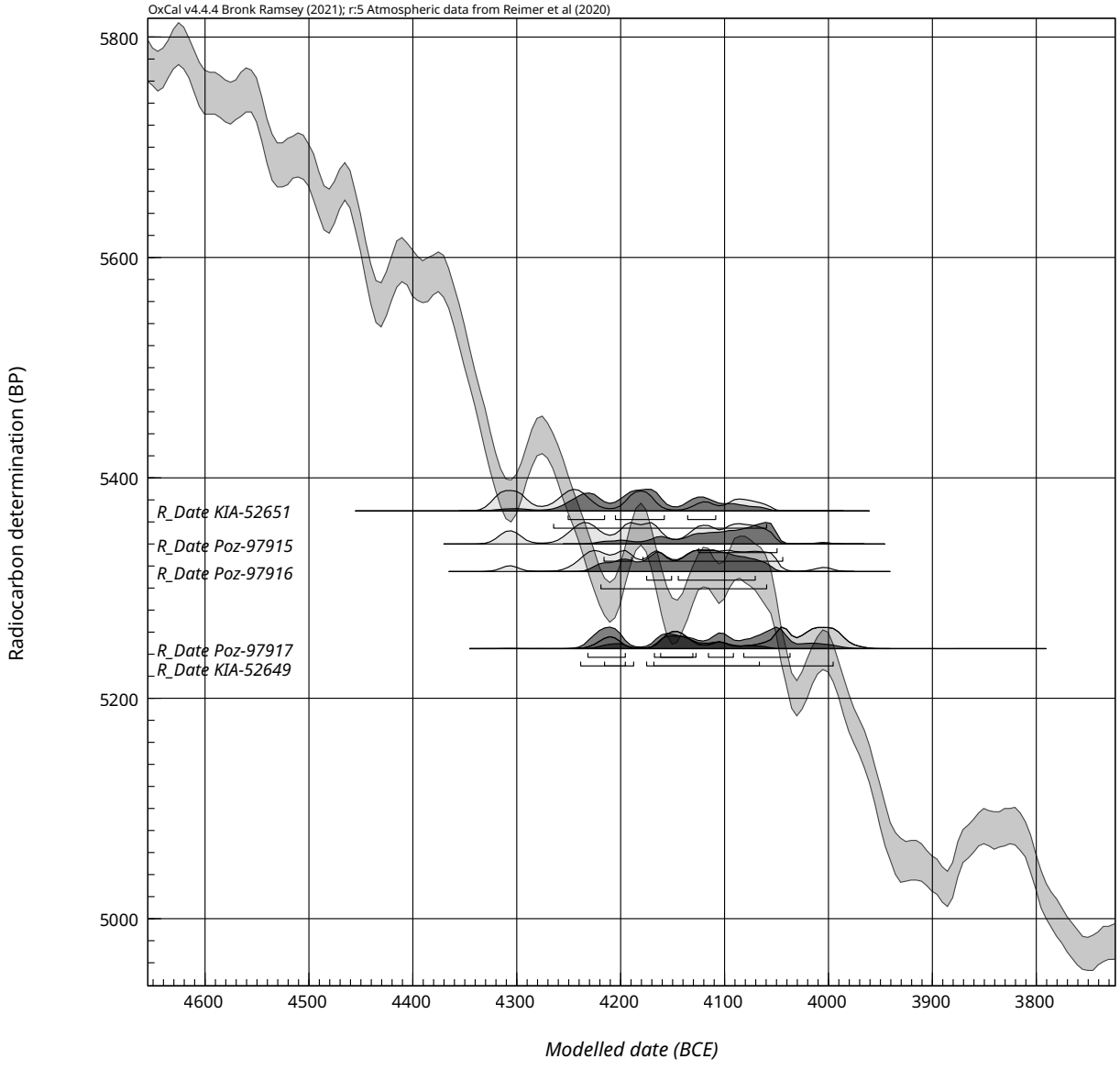


Figure 20. Zabolotne: curve plot of five modelled ^{14}C dates from Trench 2 under exclusion of outlier KIA-52650.

Ternivka

Magnetic survey

The archaeomagnetic survey at the Ternivka settlement was conducted over an area of 9 ha (Figs. 2, 7). Anomalies of archaeological features were found over an area of 5.5 ha. Part of the settlement (approximately 1.5 ha) is occupied by forest and a field road. Therefore, the total area of the Ternivka settlement is approximately 7 ha. An oil pipeline runs back to back with the features on the south-western outskirts of the settlement.

In the report on archaeological fieldwalking in Ternivka in 1996, it was claimed that the area of the settlement is 1300 × 200 m (Levada 1996, 18, Fig. 17). To confirm this information, small search strips using a magnetometer were conducted outside the settlement, 50–60 m away from the easternmost anomalies of features, and one long search strip, 600 m to the north-east of the settlement. However, no features were found.

Magnetic anomalies of the Ternivka settlement can be divided into following categories:

- 49 rectangular anomalies, which are the ruins of burnt wood-clay buildings[2].
- 9 rectangular anomalies of buildings, burnt with less intensity or eroded.
- 1 rectangular anomaly of unique building, so-called 'mega-structure'.
- 77 anomalies of different-form pits.

The planning of the Ternivka settlement resembles Zabolotne, but on a smaller scale. The buildings are organised mainly in two concentric rows. The inner row is 160 × 115 m. Between the rows there is a ring-corridor 32–52 m wide, free of anomalies.

The buildings are located 3–9 m apart, in the western and southern parts of the inner row and in the southern part of the outer circle. The buildings are set less compactly in the eastern parts of both rows. The outer and inner rows have no buildings in the northern part, which is obviously due to the topographic specifics of the area, as the steep slope begins here. The north-eastern part of the inner row has only two pits.

The line of five buildings is also located outside the outer circle in the south-western part of the settlement. In addition, separate buildings were found outside the outer row, located radially or parallel to the buildings in the concentric rows. The most distant features are 40 m away from the houses of the outer circle. There are also seven buildings located in the centre of the inner row, once again, in parallel or perpendicular to the buildings of circles. The compact group of five buildings is located in the southern part of the inner space. The central area of the settlement is 60 × 60 m and is free of features.

The situation where the anomaly of the buildings reflect a spatial division in two parts is seen in Ternivka, as in Zabolotne. We also see situations where the anomaly of the building may be in three parts along its length. This is clearly seen in two buildings of the outer circle, in the eastern part of the settlement (Fig. 21). It is possible that we are dealing with buildings that consist of three rooms, or two rooms and an entrance area.

The second-category buildings (eroded/burnt with less intensity) can be found within both concentric rows and outside the outer of them.

---

2 While counting the total number of the buildings of the settlement, the wood-clay building, which was damaged by the field road and was not covered by geomagnetic scan, should be included as well. It belongs to the western part of the settlement's inner circle.

Area (m²)	Number of buildings	Share of buildings (%)
39–50	8	14.29
51–100	44	78.57
101–150	3	5.36
166	1	1.78
39–166	**56**	**100**

Table 3. Ternivka: number and percentage of buildings at the settlement grouped by area in steps of 50 m².

Areas of anomalies interpreted as buildings range from 39 to 166 m². The following regularities in the location of buildings, grouped by area in steps of 50 m² (Tab. 3) can be seen. Buildings with an area of 51–100 m² predominate, at more than 78%. Buildings with an area of over 100 m² are located exclusively in the central part of the settlement and as part of the inner circle (Fig. 9).

The biggest building, which we consider to be unique, is located at the east side of inner circle (Fig. 21). Its area is 313.5 m² (33 × 9.5 m). The 'mega-structure' is represented by the whole anomaly. The azimuth of its long axis is 108° and lies WNW-ESE. There are big pits next to it to the south, while 18 m away to the north is the nearest building of the inner circle. The western end of the building is oriented to the empty space in the centre of the settlement. Opposite the eastern end, in the course of the outer circle, several anomalies of pits are situated.

An approximately equal amount of pits are located both near the ends of the buildings and closer to their sides. The location of pits, separated from buildings were found in the southern and south-eastern parts of the settlement. Two of these are located on the ring-corridor, in its eastern part, not far from the 'mega-structure's' eastern end. The diameter of the smallest pit in the settlement is 3.5 m; the largest pit measures 19.7 × 8 m. In general, pit locations correspond to the general structure of the settlement; they are seen in both concentric rows. They are located inside the inner row and outside the outer row.

The magnetic prospection recorded a linear anomaly on the southern edge of the settlement, located in a latitudinal direction. The width of the anomaly is 2–5 m in different areas, with a length of 110 m. The western edge of the feature is near the oil pipeline, the eastern edge goes into a break in the trees of the forest caused by wind. Until invasive investigations (excavating or drilling) have been conducted, interpretation of this anomaly is difficult. It may have been the artificial ancient ditch on the edge of the settlement or the natural gully which enclosed the territory of the settlement from the south.

Excavations

Trench 1, wood-clay building and neighbouring pit

Trench 1, 5 × 2 m, was located in order to examine the north-west corner of the rectangular anomaly of the 17.7 x 5.6 m building and the south-east sector of the pit anomaly (Fig. 21). The latter is 6.7 × 4.9 m in size and is oval in form, oriented north-south. The anomaly of the pit is located 1.6 m to the north of the building anomaly. The latter is located in the southern part of the inner circular row of the settlement; its long axis has an azimuth of 13°.

The remains of the building (1003[3]) were found in the south-east corner of the trench in a 1.68 x 1.62 m area. However, the solid layer of the daub from the building is located only near the south and east walls of the trench (Figs. 22, 23). The collapsed pear-shaped vessel was found here, next to the binocular-shaped one (Fig. 24). The rest

3 After the documentation of profiles, soil samples and some other materials were taken using these numbers of contexts: 1001 (=1009), 1002 (=1010), 1003 (=1011), 1004 (=1012), 1005 (=1018), 1006 (=1012), 1007 (=1013), 1008 (=1019), 1014 (=1020), 1017 (=1015).

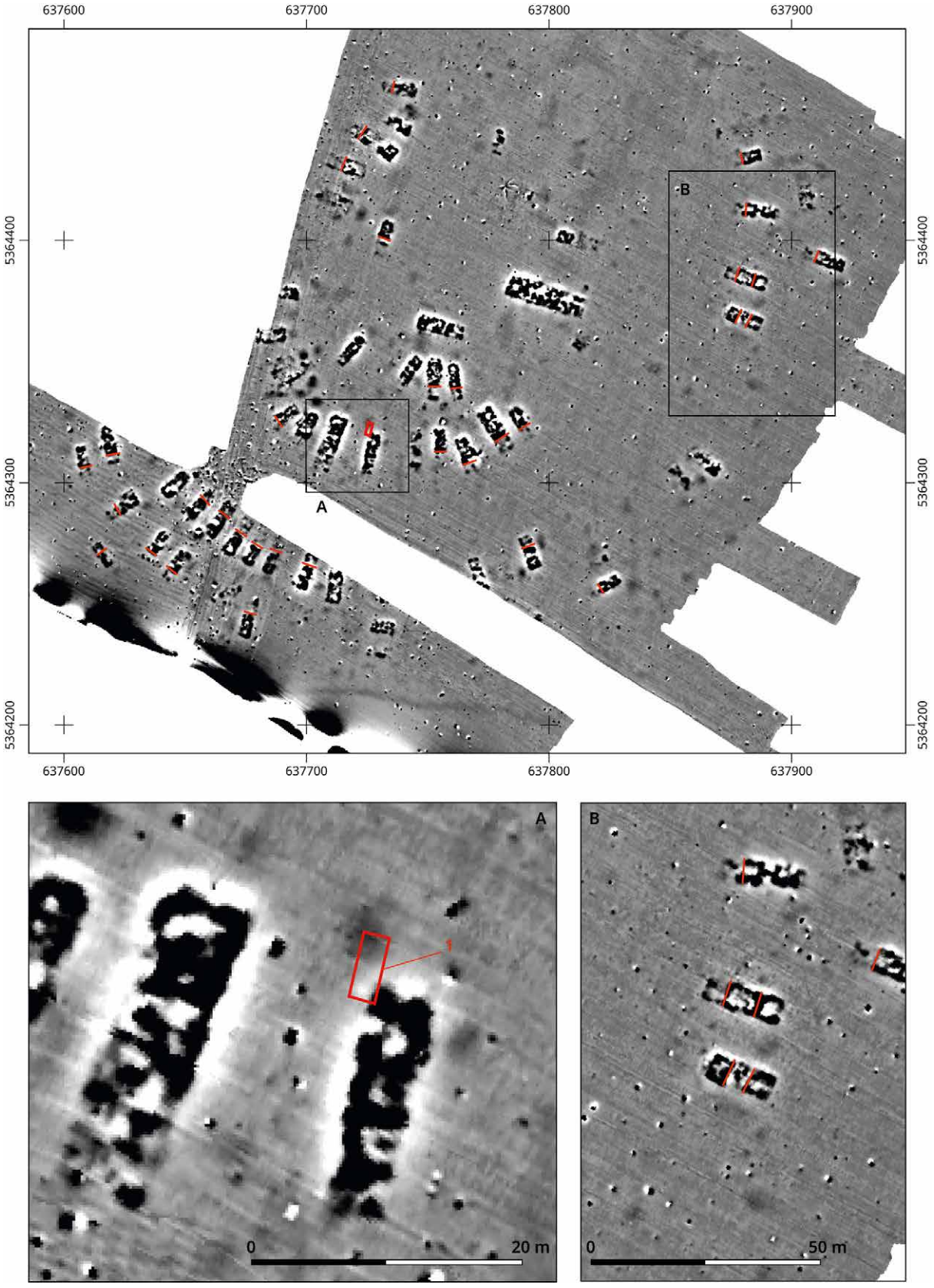


Figure 21. Ternivka: magnetic plan of the site and details of the magnetic map showing the location of Trench 1 (A) and the possible houses divided into two or three parts (B).

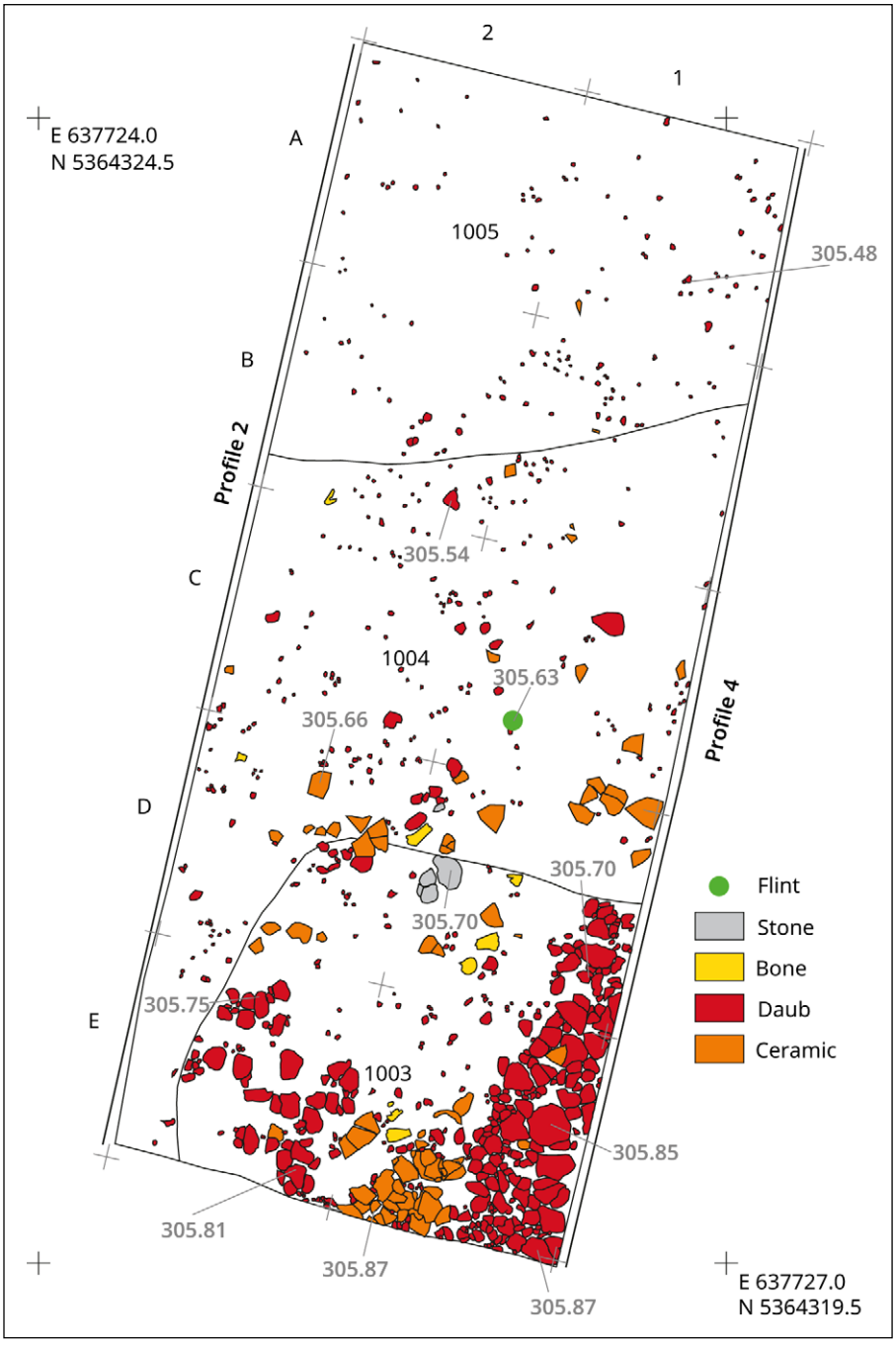


Figure 22. Ternivka, Trench 1: Planum 1 displaying the daub layer (1003) of the structure, the artefacts outside the structure (1004) and the upper part of the pit filling (1005). Location of Profiles 2 and 4.

of the building area contained single fragments of the daub, pottery, animal bones and stone. The area of the cultural layer (1004) outside the building contained the same inventory. The amount of artefacts found is greater near the building but towards the pit (1005) the numbers decrease. The ruins of the building (1003) consisted of burnt clay fragments mostly 5–15 cm in size. The colours are yellow-grey, red-grey, and the inside of the majority of the fragments is black-grey. Both surfaces of most of the fragments are flat with a thickness of 4–6 cm. Only two fragments had imprints of split wood on the bottom, the direction of which is West-East. It appears that these flat fragments are the remains of the platform, while amorphous ones could be either remains of the upper layer of the daub (walls) or fragments of the platform.



Figure 23. Ternivka, Trench 1: photo of Planum 1 displaying the daub layer (1003) of the structure, the artefacts outside the structure (1004) and the upper part of the pit filling (1005). View from the south.

The ruins of the building were covered by two humus layers. Directly above there was a thin (8–18 cm) layer of black-grey soil with a yellowish shade (1002), above which is Chernozem (1001) approximately 40 cm thick. Layer 1006 is a loam below the building which contained mostly daub crumbs as well as single fragments of ceramic vessels and animal bones up to 10 cm in size, as well as the collapsed goblet and a bone tool.

The location of the separate findings in Layer 1004 outside the building marks the ancient horizon at a level of 305.54–305.66 m asl.

The sector of the pit is examined in the northern part of the trench (Figs. 25, 26). It was dug into the layer of loam (1007) and loess (1015). The deepest point of the pit within the examined area is at a level of 304.28 m asl. Therefore, the pit was 1.3 m deep.

The upper layer of the pit (1005), which is probably of natural origin, contained a small amount of daub, bones and pottery fragments up to 10 cm in size (Figs. 27–29). The larger amount of these artefacts, some of which were bigger than 10 cm, were found in the Context 1008. This layer also contained small (up to 1 cm) fragments of charcoal, anthropomorphous figurines and clay artefacts.

Fragments of the disk (or disks) which are 4.5 cm thick and made of a mixture of clay with chaff were found in the layer. The colour of the product after firing is





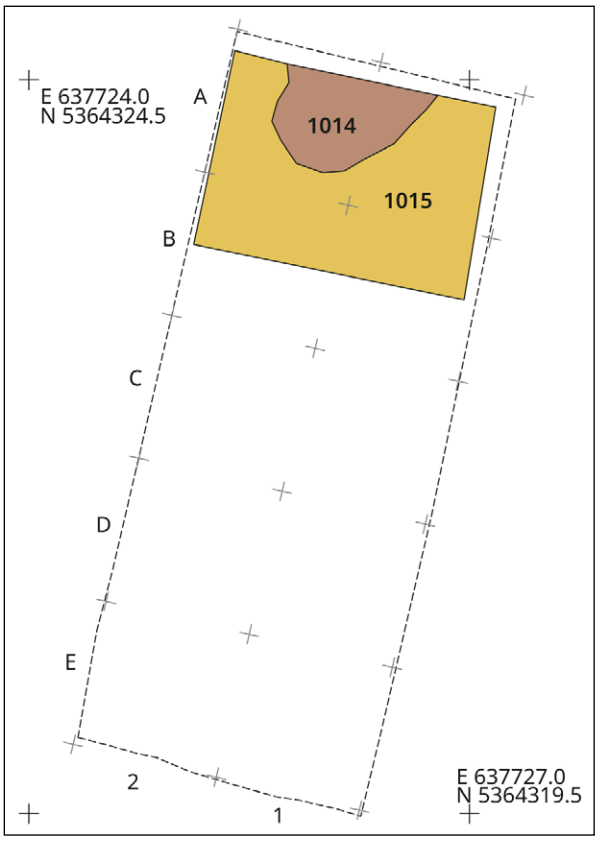


Figure 24 (opposite page, above). Ternivka, Trench 1, Planum 1: photo of part of the daub layer (1003) of the structure with collapsed pottery of pear-shaped and binocular forms. View from the south.

Figure 25 (opposite page, below). Ternivka, Trench 1: photo of Planum 2 displaying the loam layers (1006, 1007) under the cultural layers (1003, 1004) and the pit filling (1005). View from the north.

Figure 26. Ternivka, Trench 1: Planum 6 (304.35–304.37 m asl) displaying the bottom part of the pit.

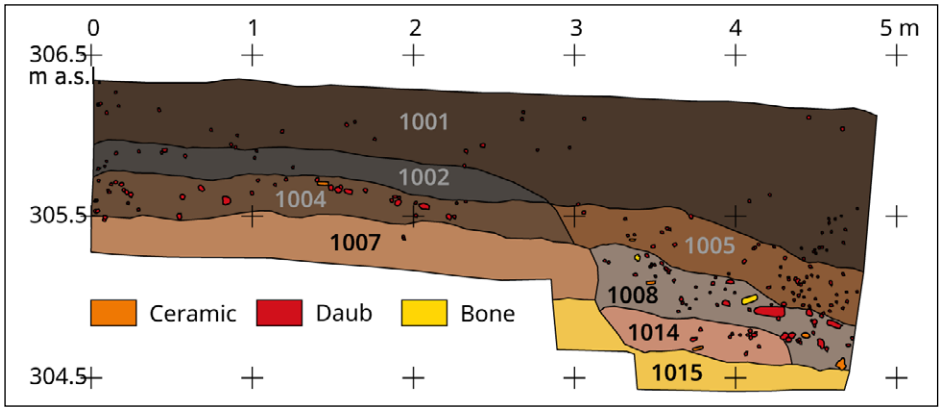


Figure 27. Ternivka, Trench 1: Profile 2 displaying the stratigraphy of the pit and the position of the artefacts between the structure and the pit; 1001 – black-grey; 1002, 1005 – black-grey, yellowish; 1004 – grey-yellow; 1007 – yellow-grey; 1008 – black-yellow; 1014 – dark-grey, yellowish; 1015 – light-yellow.

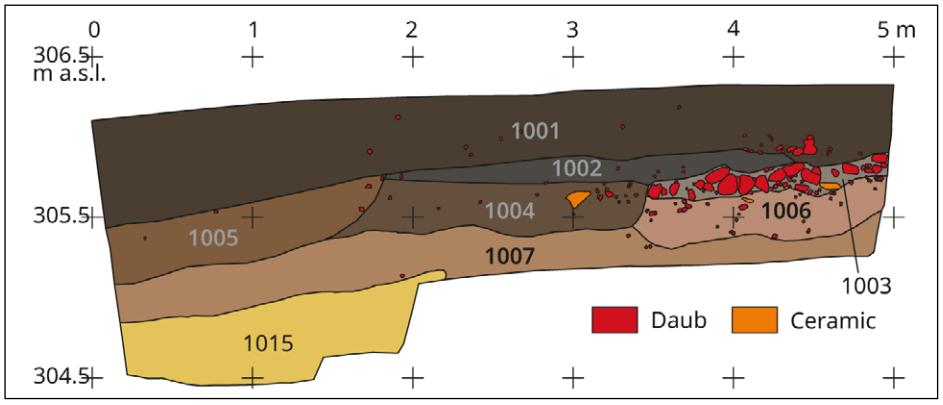


Figure 28. Ternivka, Trench 1: Profile 4 displaying the stratigraphy of the pit, structure and the position of the artefacts between the structure and the pit; 1001 – black-grey; 1002, 1005 – black-grey, yellowish; 1003 – daub layer; 1004, 1006 – grey-yellow; 1007 – yellow-grey; 1015 – light-yellow.



Figure 29. Ternivka, Trench 1: photo of Profiles 2 (right) and 3 (left) displaying the stratigraphy of the pit filling.

dark-red, the product is fragile in structure. It is hard to describe its form due to the extensive fragmentation but judging by the rounded edges it was circular or oval, with a diameter of at least 40 cm.

Layer 1008 included another clay artefact (or artefacts). This also was flat, with a thickness of approximately 5 cm; its form is rectangular with sides curved outwards. It is made of a mixture of clay with chaff. The firing of the artefact is mostly even, as is indicated by the uniform dark-red colour of the product. The outer surface and sides of the artefact are smooth and covered by painting, which is grey-yellow with a green shade. The lower part is humped which indicates it is sticking to some surface, possibly clayish. The artefact is ornamented with a wide incised line along the edge (Fig. 30). It may be some kind of plastic decoration.

The lower layer of pit filling (1014) contained soil with burnt clay crumbs, small fragments of charcoal and single fragments of pottery, flint and stone tools.

The presence of the artefacts below the ruins of the building and the imprints of wood on the underside of the daub fragments indicate that the building had two floors. The pit was located near the edge of the building which allows the connection of these features as parts of one household complex, while the filling of the pit indicates the activity of the inhabitants of this building. As is usual, we assume that the pit was dug in order to obtain building material. The lower layers of the pit's filling contain ordinary domestic waste, including fragments of clay decoration from the building interior. Considering that the decoration fragments in the pit are in a fired condition, these may have been the ornamentation of the oven walls or some other parts of the interior which was under the influence of high temperatures. Clay disks, fragments of which were found in the pit, are usually interpreted as movable stands for the pottery in the kiln, and which were also used to cover the firing channels (Videiko *et al.* 2015).



Figure 30. Ternivka, Trench 1: photo of clay interior decoration with incised line found in the pit; Find-ID 1175.

^{14}C dating

From cattle bones recovered in the debris of the burnt house under investigation (Context 1003), we obtained the two ^{14}C dates Poz-97912 and Poz-97892 (Suppl. 1 in Chapter 19, this work, Vol. II). According to a Bayesian model, the house was most probably in use between 4220 and 3969 BCE (Tab. 4; Fig. 31).

Soniachne

Magnetic survey

The geomagnetic survey of the promontory where the Soniachne settlement is located was performed over an area of 2.1 ha (Fig. 32). In our opinion, two anomalies of archaeological features were discovered as a result (Fig. 7). The first one has a rectangular form and measures 14.3 × 6.7 m. We interpret it as the remains of a burnt wood-clay building. The second anomaly is not as clear as the first one and is located 1.8 m away to the south-west from the first anomaly. It is approximately oval in form and measures 7 × 5.6 m. It is possible that both anomalies are parts of one household complex with the building and the pit nearby. It is also possible that the pit anomaly is the reflection of the geological structure of the area surveyed rather than being an archaeological feature.

Excavations

Profile 1, cultural layer

The cleaning of the cultural layer was conducted before the magnetic survey was performed. Profile 1 was localised at the west edge of the modern pit, 0.25 ha square, which appeared to be due to soil digging, presumably for building the nearby levee on the pond (Fig. 32). The width of the cleared area is 3.5 m, the height, in relation to the pit's depth, is 1.4 m.

Three consecutive stratigraphic layers were discovered (Fig. 33). On the top is the Chernozem layer (1001), 83–88 cm thick, below it is the loam (1002), 42–52 cm thick. Below that is the loess layer (1003). Generally speaking, in the upper part of Horizon 1002 the remains of the cultural layer were found, represented by the fragments of daub (up to 7 cm in size) with the admixture of chaff and ceramic vessels

Table 4. Ternivka: Bayesian model of the use of the house investigated in Trench 1. A_{model}=99.5, $A_{overall}$=99.6. All boundary dates BCE, duration in years.

	Dating range 68.2%	Dating range 95.4%	Median	Highest dating probability
Boundary, start of house use	4314–4005	4659–3994 (90.2%)	4215	4220 or 4150 or 4050
Duration	0–73	0–180	35	230 or 160 or 60
Boundary, end of house use	4156–3841	4216–3515 (89.1%)	3969	3990

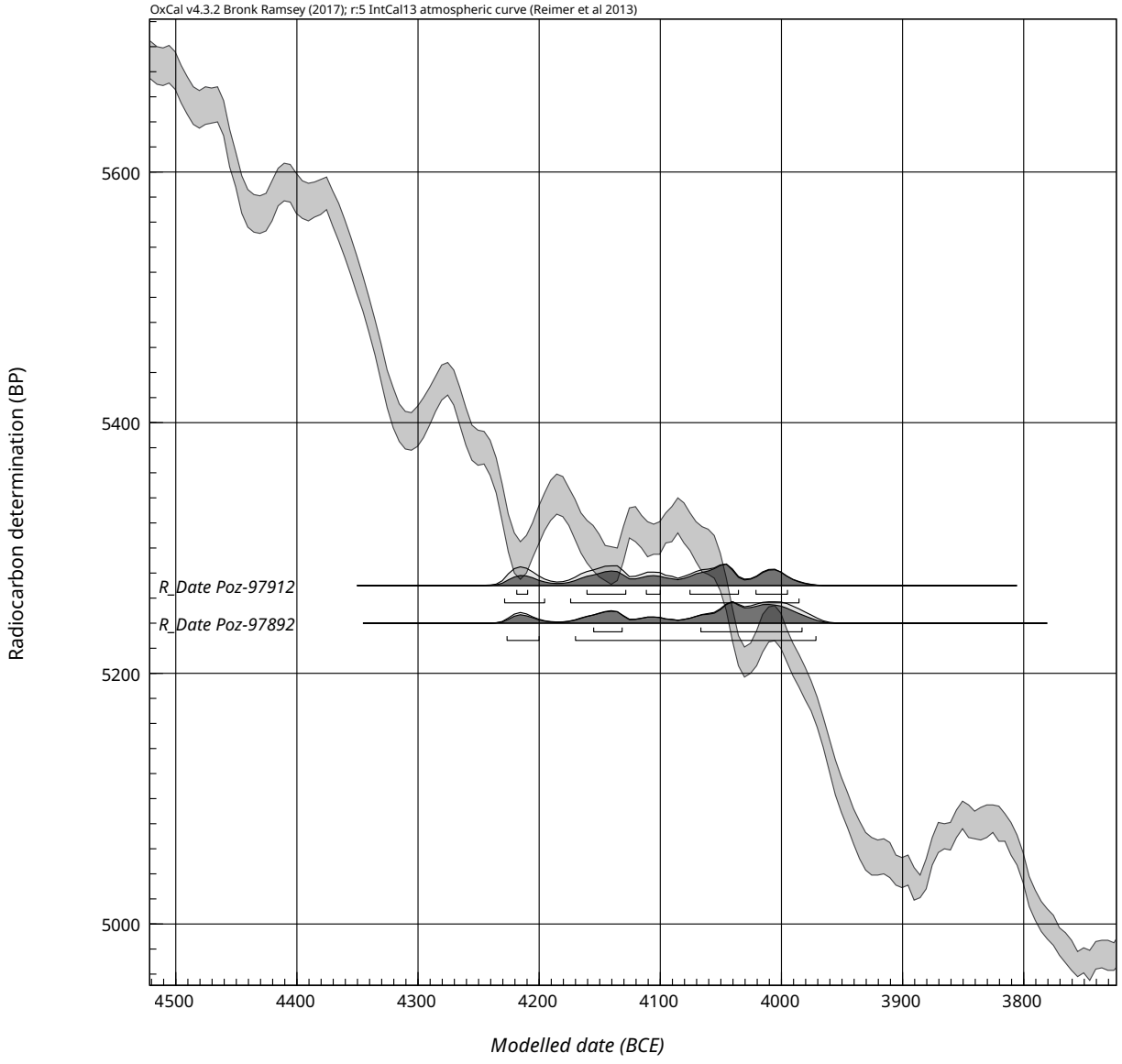


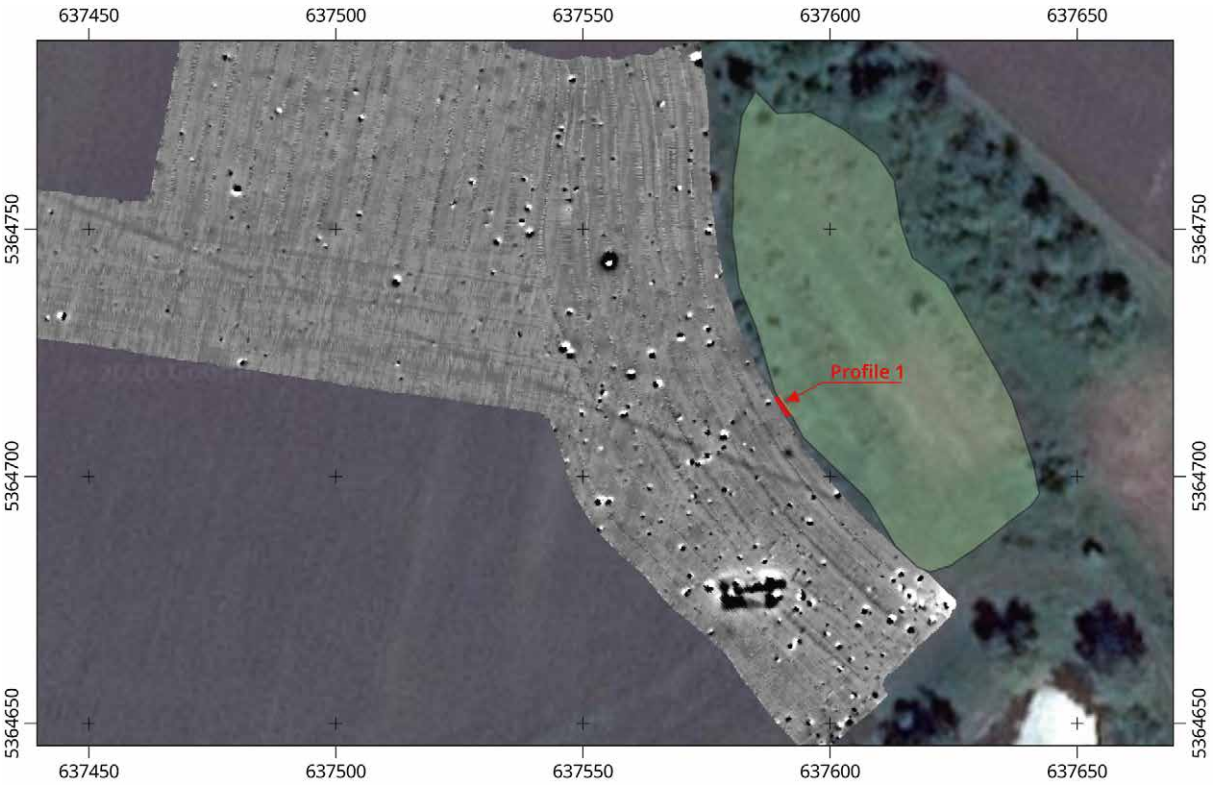
Figure 31. Ternivka: curve plot of two modelled ^{14}C dates from Trench 1. A_{model}=99.7, $A_{overall}$=99.8.

(up to 10 cm in size). At the level of 286.51 m asl a fragment of an anthropomorphic figurine was found, while at the level of 286.59 m asl a fragment of flint was found.

Therefore, this confirmed the presence of a weak cultural layer of Trypillia culture to the north of the features found by magnetic survey. The cultural layers within the modern pit are destroyed until the loess horizon.

^{14}C dating

No ^{14}C dates were obtained from the site of Soniachne.



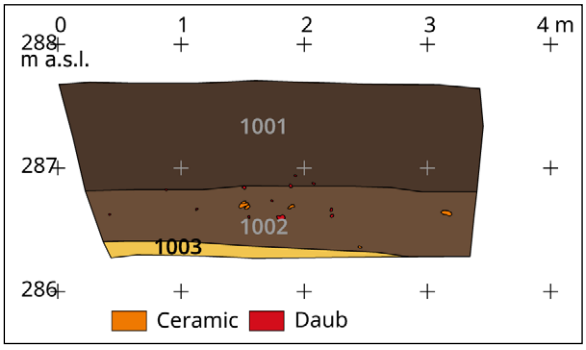


Figure 32 (above). Soniachne: magnetic plan of the site against the background of the Google satellite image and location of Profile 1 at the edge of the ground extraction territory (light green).

Figure 33. Soniachne: Profile 1 displaying the level of the cultural layer of the site; 1001 – black-grey; 1002 – grey-yellow; 1003 – light-yellow.

Hariachkivka 3

Research history

The site was initially discovered during fieldwalking by V. T. Zahoruiko in 1993 (Zahoruiko 1993, 2–3, Fig. 4, Fig. 11: 23–29, Fig. 13; Lototska and Ocheretnyi 1997; Zahoruiko and Shumova 1997). In spring 2018 in a joint project between CAU and IA NASU magnetic surveying of the settlement was conducted. In summer 2019 the test excavation of one anomaly was carried out based on the results of the magnetic survey. The other two test trenches were located on the western part of the site, outside the territory surveyed by magnetic equipment.

Geographical position

The Hariachkivka 3 settlement (48°20’22.8”N, 28°46’07.8”E) is located on the north-eastern outskirts of the village of Hariachkivka in the Horodkivka territorial community of the Tulchyn Raion. It is located on the sloping edge of the plateau, which goes down to the left bank of an unnamed river which flows from north of the village and joins the Hariachkivka River to the south of the village (the river flows → Hariachkivka → Vilshanka → Markivka → Dniester; Fig. 34). The river is to the west of the settlement. On the south side the site is delimited by the gully. The earth’s surface within the settlement has a mostly west-facing exposition and the average slope is around 7%.

Approximately through the centre of the settlement runs the field road in an almost meridian direction. The territories of the settlement to the east of the road are located on an agricultural field. In the western part of the settlement there are numerous homesteads of the local inhabitants. Several modern buildings are built on the western edge of the settlement.

Based on the large amount of the daub fragments from the wooden-clay buildings, which were found on the modern earth’s surface, the buildings in the north-western part of the settlement are severely damaged, if not virtually destroyed.

Magnetic survey

The magnetic survey was conducted over an area of 4.1 ha. We discovered that the anomalies of the archaeological features are located over an area of 3.3 ha (Fig. 35). The survey covered the eastern part of the settlement, which is on the field to the east of the road. The territory to the west of the road, where the homesteads are, was not magnetically surveyed. However, fieldwalking was conducted, during which the clusters of the artefacts on the modern surface were mapped. Considering the results



Figure 34. Hariachkivka 3, view of the site from the south. Photo taken during the magnetic survey of the site in April 2018.

of the magnetic survey and distribution of surface finds, as well as the morphology of the relief the area of the settlement must have been approximately 7 ha. The presence of the surface artefacts near the river too extends the territory of the settlement to 9 ha. However, it is possible that the artefacts could be by the river bank as the result of denudation processes.

At the Hariachkivka 3 settlement the following categories of magnetic anomalies were found:

- 40 rectangular anomalies, which are the ruins of burnt wooden-clay buildings.
- 6 rectangular anomalies of the buildings which were burnt with less intensity or eroded.
- 1 anomaly of the mega-structure.
- 55 anomalies of pits of various forms.

Figure 35. Hariachkivka 3: magnetic plan (∓2 nT) of the site against the background of the Google satellite image. Additionally, the plan shows the distribution of Trypillia artefacts on the modern surface and the location of Trenches 1, 2 and 3.



- An oval anomaly outside the settlement.
- 5 linear features, presumably a pathway.
- A linear anomaly of the natural gully.

The structure of the settlement represents the most common planning for the Trypillia, the basis of which are the two concentric rows of buildings and, between them, the ring-corridor, free of buildings (Fig. 36). Based on the area scanned, the diameter of the inner row is approximately 155 m. It is compactly occupied with buildings, except for the area in the north-eastern part, which is occupied by anomalies of the pits and in the centre of which the mega-structure is located. The closest buildings of the inner circle are located 36 m to the north and 27 m to the south of the mega-structure. Groups of pits are located in these areas. Anomalies of pits are also located near the western edge of the mega-structure.

The area of the mega-structure is 579 m^2 (around 44 × 13 m). The azimuth of its long axis is 89°. Around 15 m of the mega-structure's eastern part is occupied by a strong anomaly, which indicates dense filling of the daub in this area (Fig. 37). On the rest of the territory the anomaly shows clear contours of the building and indicate the presence of the separate daub clusters (presumably interior objects) within the building.

Only a small area inside the inner circle has been examined, so it is too early to talk about the archaeological features density in this area. We can only say that it is not completely free of buildings, since two anomalies of the buildings have already been found. They are located in the south-eastern part of the settlement centre. The pit anomalies are also located near the buildings.

The ring corridor between the circular rows is 32–42 m wide in the northern and southern parts and extends (up to 55–65 m) in the eastern part. The diameter of the outer circle is 265 m, it has dense regular building. The distance between the buildings within the circle is 2 to 11 m. In the southern part there is a space free of buildings 20 m wide. In the north-eastern part, opposite the mega-structure, the width of the site entrance is 71 m. In the central part of the entrance there are two weak anomalies of buildings. The long axis of the smaller, western one is located in the radial direction; the larger, eastern one is perpendicular to the western one. To the east of the bigger building, outside the course of the outer circular row, a large oval anomaly, 250 m^2 in size (20.5 × 15.0 m), is located. The magnetic flux density of the anomaly has positive value of less than 1 nT, similar to the anomalies of the pits.

The buildings outside the outer circle are located only in the south-eastern part of the settlement. They are planned in two short straight rows; one is parallel to the line of buildings of the circle, the other one is perpendicular (radial) to it. Two more stand-alone buildings are located perpendicular to the buildings of the circle.

The longitudinal division of the anomaly into two parts is visible for 18 buildings (see the description of the magnetic plan of the Zabolotne settlement). The first one is the entrance part, which occupies about 1/3 of the building, the second one is the main room, which occupies about 2/3 of the building. Based on this we can say that the entrance to the buildings in the circular rows was located beside the ring-corridor. The entrance to the buildings of the straight row which is located parallel to the buildings of the outer circle, is oriented in the opposite direction from the centre of the settlement.

The area of the anomalies, which were interpreted as buildings, varies from 34 to 255 m^2 (Tab. 5; Fig. 38). Most of them (68%) are 51–100 m^2. They are spread all over the settlement. There are a few buildings with areas of less than 50 m^2 or more than 100 m^2. The smallest buildings are located in different parts of the settlement, but the largest ones are located near the mega-structure.

No system was seen in the location of the pits at the settlement. Sometimes they are located near the edges of the buildings, opposite to the entrance, but most of

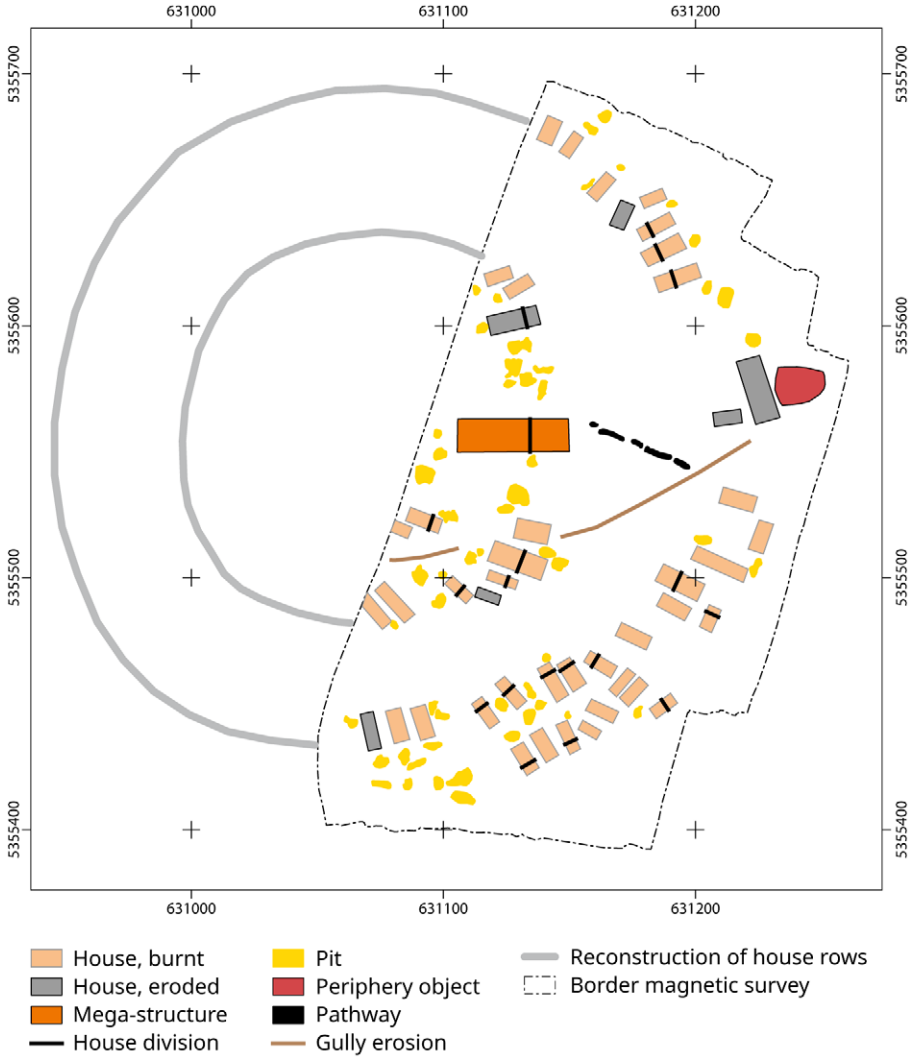


Figure 36. Hariachkivka 3: interpretation of the magnetic features.

the time they are located near the lateral walls of the buildings and in groups. For example, two groups of the pits are located to the north of the mega-structure and outside the outer circle in the southern part of the settlement comprise almost 1/3 of the pit anomalies. The biggest pit is 9 × 8 m in size, the rest are smaller.

In the eastern part of the settlement there are 5 anomalies of features, which are arranged one by one, forming a line 2 m wide and 43 m long. It goes from the eastern edge of the mega-structure to the south-east, crossing the ring-corridor. Perhaps this linear structure represents some kind of pathway from the mega-structure to the buildings of the outer house ring (circuit), or into the surrounding area of the site via the settlement entrance marked as a gap in the house ring (cf. black linear anomaly on Fig. 36).

The second linear structure, which is made up of two anomalies, goes south-west from the site entrance in the outer circle, crossing the inner row of the buildings. Considering the natural depression of the earth's surface in this area, we assume that the anomaly is the result of soil accumulation due to water erosion.

Therefore, the settlement is built in two concentric rows of the buildings; between them there is a ring-corridor free of buildings. The centre of the settlement is partly occupied by the buildings; a dozen of the buildings are located outside the outer row. In the north-eastern part of the inner circle, which is free of buildings, there is a mega-structure, opposite this is the pathway to the site entrance in the outer circle. Opposite the entrance on the outskirts of the settlement there is a large oval anomaly, which

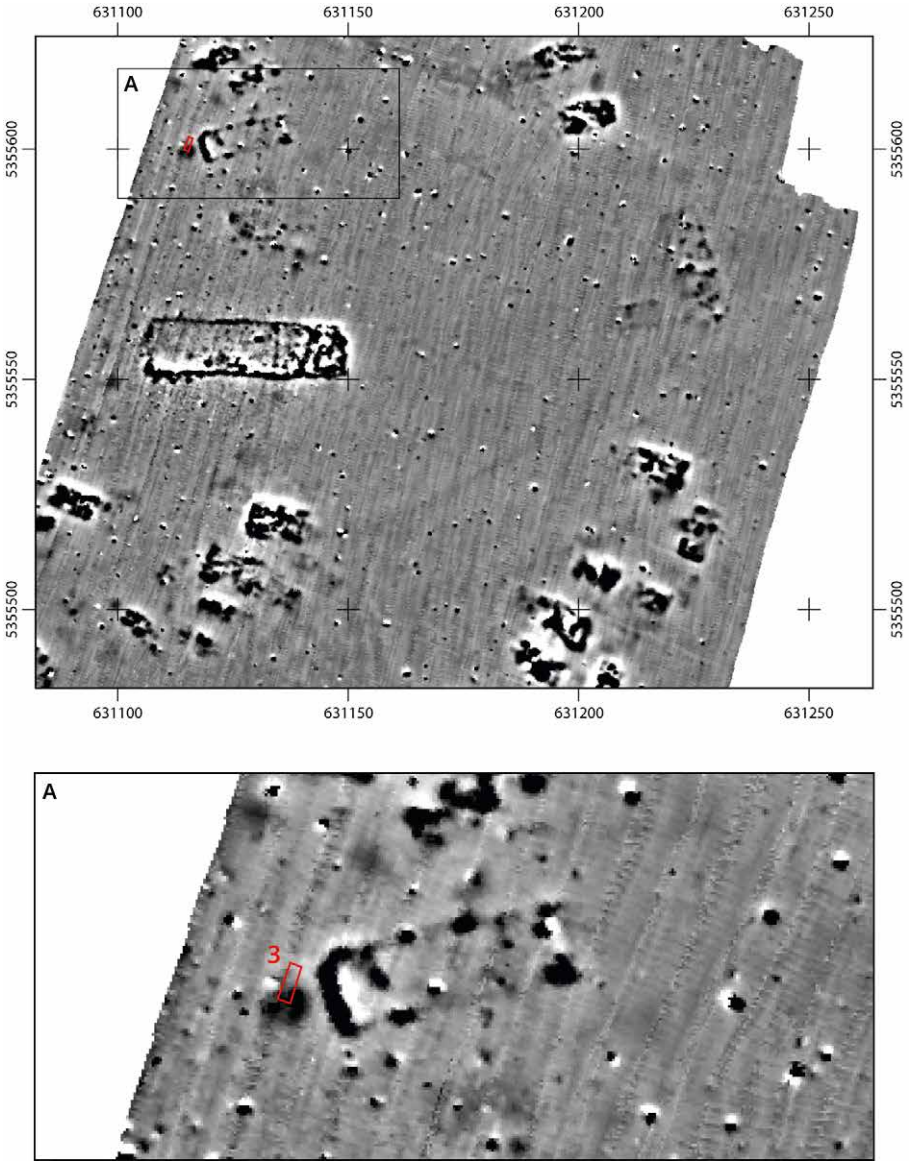


Figure 37. Hariachkivka 3: eastern part of the site with the mega-structure, entrance in the outer circular row and (A) the location of Trench 3.

resembles the deepened feature. We can find analogies to this at later settlements, for example Stolnicheni 1 (Țerna *et al.* 2019, 246–248) and Petreni (Rassmann *et al.* 2016, Fig. 12). The largest buildings in the settlement are located near the mega-structure.

Excavation

The test excavations at the Hariachkivka 3 settlement were conducted at three objects. Trenches 1 and 2 are located in the western part of the settlement, outside the magnetically scanned area (Fig. 35). This is because of the absence of approval from the owner for the excavations in the eastern part of the settlement. However, it has also allowed examination of the state of preservation of the settlement's cultural layer on the sloping areas of the western part. Trench 3 is located in the eastern part of the settlement, given the location of the magnetic anomalies (Fig. 35).

Trench 1, destroyed cultural layer

Trench 1.1 × 5 m in size, is in the northern part of the settlement, near and to the west of the road, where the features of the inner circular row are located. The largest

Area (m²)	Number of buildings	Percentage of buildings (%)
34–50	6	13.64
51–100	30	68.18
101–150	5	11.36
151–200	2	4.55
201–250	-	-
255	1	2.27
34–255	**44**	**100**

Table 5. Hariachkivka 3: number and percentage of buildings at the settlement grouped by area in steps of 50 m².

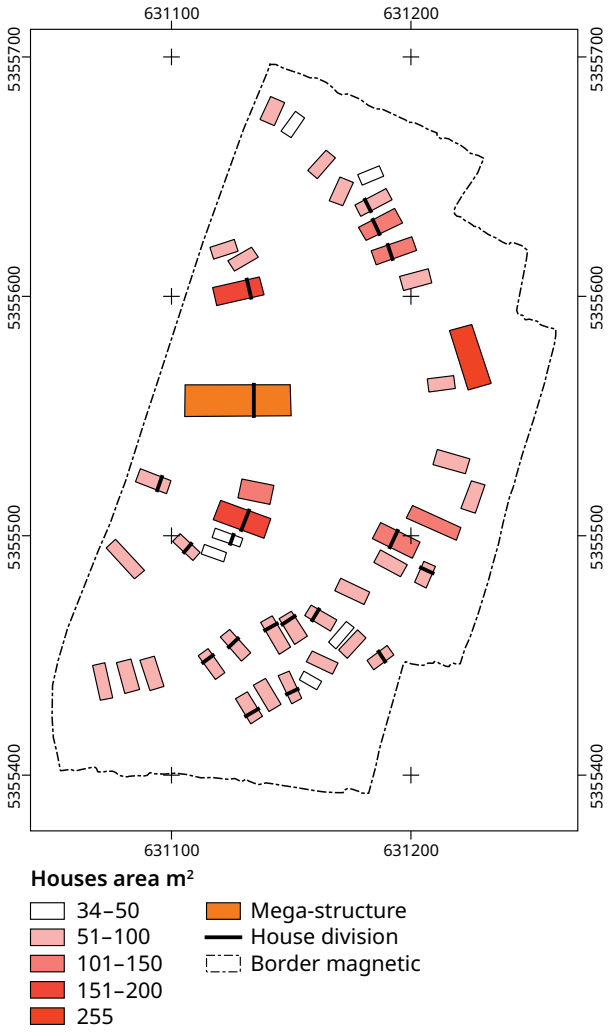


Figure 38. Hariachkivka 3: location of the houses categorised by size.

building of the row is located 17.5 m to the south-east of the trench. On the modern ground surface in the location of the trench, a large amount of daub fragments from the wood-clay buildings was found.

In the trench (Fig. 39), under the thin layer of Chernozem (1001) up to 16 cm thick, a dark-yellow natural clayish layer (1002) is located. In the northern part of the trench, on the edge of these layers, fragments of daub wooden-clay buildings were found, but all of them, including those in Layer 1001, are displaced. Separate fragments of the daub are also located in the upper part of Layer 1002. They are



Figure 39. Hariachkivka 3: photo of Trench 1. View from the north-west.

probably evidence of the location in this part of the edge of the building which was completely destroyed as a result of erosion and modern agricultural activity.

Trench 2, wood-clay building

Trench 2 was also located with respect to the larger amount of daub found concentrated on the modern ground surface. The area of the trench is 5 × 1 m. We assume that Trench 2 is located in the area of the settlement's outer circular row of buildings.

The ruins of a wooden-clay building were found in the central and northern parts of the trench (Figs. 40, 41). They are represented by the Contexts 2002 and 2004. Context 2002 is significant for the compact cluster of daub with admixture of chaff. Most of the fragments are up to 10 cm in size, some are 15–20 cm in size; their thickness is 4–8.5 cm. The fragments have flat surfaces and imprints of split wood below. The wooden constructions are located along a north-west/south-east line. In the central part of Context 2002 vitrified fragments of daub were found. Separate fragments of pottery, which are marked on the Context 2002 (Fig. 40), are mostly located below or under the daub fragments, in Context 2005. The next context of building ruins, 2004, is located in the northern part of the trench and is mostly represented by small fragments of daub and clay crumb, which are located in the layer of yellow-grey soil. In the southern part of the trench, at the level of building ruins, in the layer of black-yellow soil (2003), separate fragments of pottery and daub were found.

Above these contexts there is a Chernozem layer 37–42 cm thick (Fig. 42). The upper layer of Chernozem (2001) is homogeneous all over the trench. It includes a few separate small fragments of daub, up to 5 cm in size. The lower layer has been divided into two contexts, 2001a and 2001b. The Context 2001b is above the ruins of the building and includes the large amount of daub fragments, up to 10 cm in size. Context 2001a contains small fragments of daub and is located above the Context 2003.

Thus, part of the two-storey wood-clay building was examined with this test trench. Contexts 2002 and presumably 2004 are the remains of the platform.

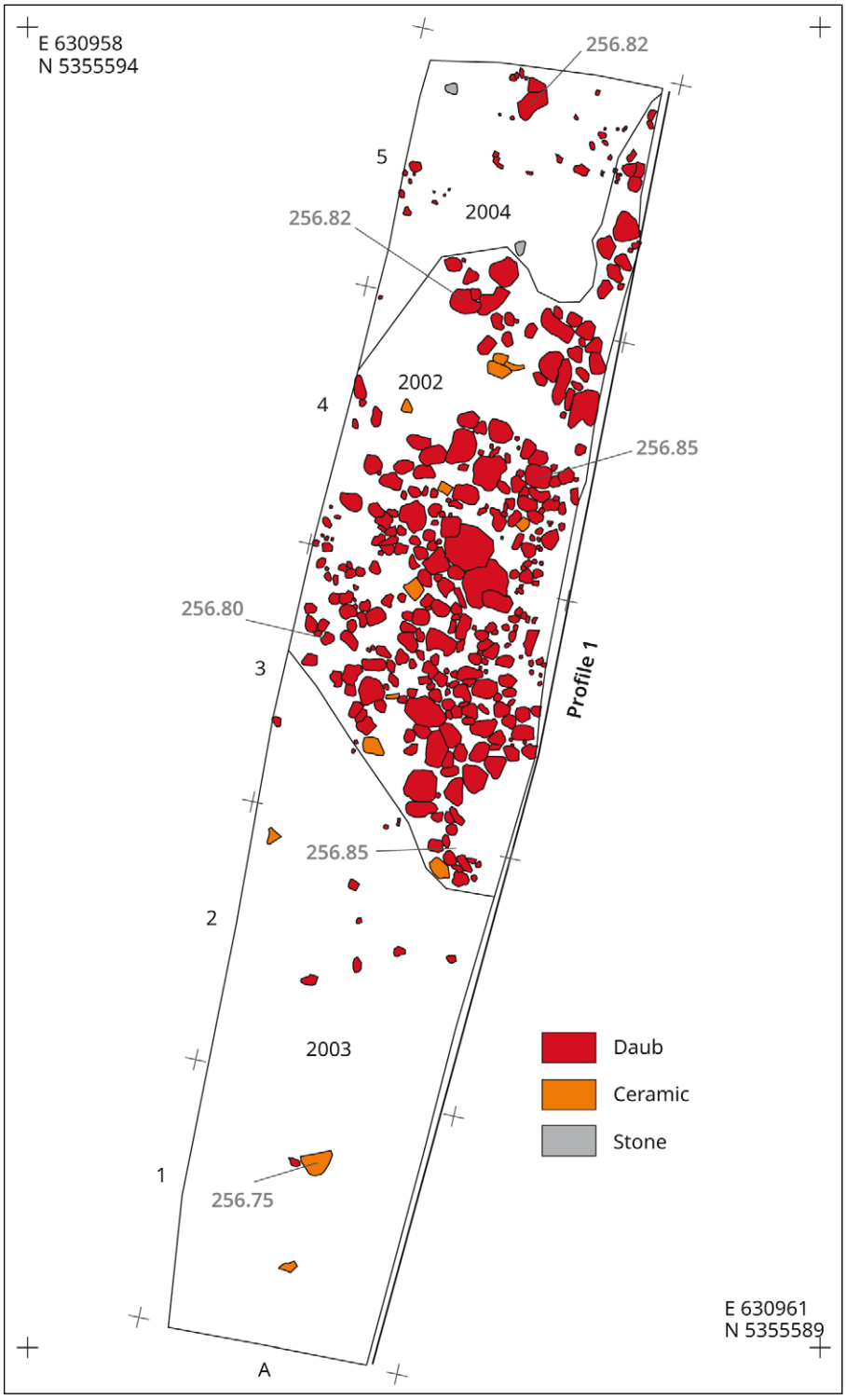


Figure 40. Hariachkivka 3, Trench 2: Planum 1 displaying the collapsed daub layer (2002, 2004) of the structure and the location of the artefacts (2003) outside the structure. Location of Profile 1.

Since the wooden base of the platform is usually located across the long axis of the building, we assume that the investigated building is oriented in the direction north-east/south-west. The upper layer of the building was destroyed by agricultural activity, as is indicated by the large amount of daub fragments in Context 2001b. The findings in Context 2005 are the materials located at the ground floor level. The artefacts of Context 2003 presumably mark the level of the ancient surface outside the building, which is at the level of 256.7–256.8 m asl. Near Trench 2 the destruction



Figure 41. Hariachkivka 3, Trench 2: photo of Planum 1 displaying the collapsed daub layer (2002, 2004) of the structure and the location of the artefacts (2003) outside the structure. View from the north.

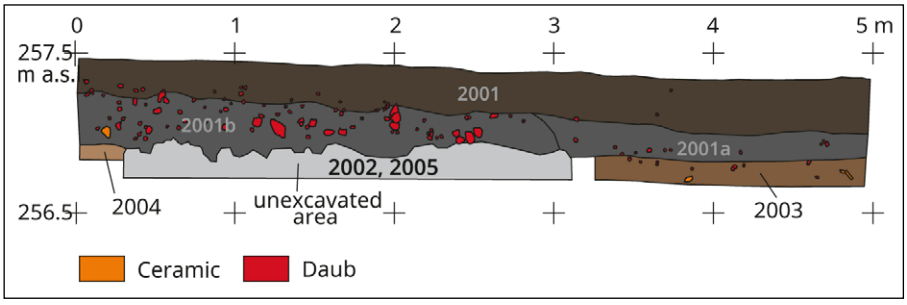


Figure 42. Hariachkivka 3, Trench 2: Profile 1 displaying the stratigraphical position of the structure and the position of the artefacts outside the structure; 2001, 2001a, 2001b – Chernozem; 2002 – daub layer, platform; 2003 – black-yellow; 2004 – destroyed daub layer; 2005 – yellow grey, ground floor.

of the settlement's cultural layer did not occur in recent times. It confirmed by the small amount of the artefacts in the upper layer of Chernozem (2001).

Trench 3, pit

Test Trench 3 has an area of 1 × 3 m and was located in order to examine the eastern part of the oval anomaly 5.3 x 3.8 m in size. The anomaly is 0.9 m to the north of the weak anomaly of the building. The latter is 20.3 x 7.6 m in size and is oriented in a north-east/south-west line. The building is located in the north-eastern part of the inner concentric row, 35 m to the north of the mega-structure.

Part of the pit was examined in the central and southern parts of Trench 3. The deepest part of the pit is found in the southern part of the trench at the depth of 268.42 m asl (Fig. 43). The pit has a flat bottom and sloping walls. The initial depth of the pit was probably 50 cm, which is indicated by the filling thickness, as represented by Contexts 3004 and 3002. The first of these is the bottom filling of the pit up to 34 cm thick, which contained some pottery, bones and daub up to 10 cm big, located in the grey-yellow layer of soil. Context 3002 lies above Context 3004 and represents the upper part of the pit's filling. Some pottery and daub fragments up to 10 cm in size as well as several fragments of bones and flint were found here, in yellowish grey-black soil. The filling of the pit was covered by the Chernozem layer (3001) 35–40 cm thick, which contained some daub fragments as well as clay crumb. The upper part of Chernozem (3001a), the topsoil, is more compact than the lower (3001b).

The pit was dug in a layer of the yellow-grey loam (3003). Considering the area and assuming that the depth of the pit is no more than 0.5 m all across its the area, its approximate volume is about 8 m^3. This is the amount of building materials which can be acquired from this pit which appears to be insufficient for the construction of the nearby building with an area of 154 m^2. Perhaps this indicates a different construction method for the building, for example with minimal use of clay, such as at the Nebelivka settlement (Rud 2015a; Videiko *et al.* 2015). However, the building anomalies from Nebelivka and Hariachkivka 3 are different. In the first case, we have a low-value magnetic flux density and mostly homogeneous anomaly, while in the second, there are separate anomalies with high magnetic values, which mostly form the contour of the structure. The building anomaly from Hariachkivka 3 may indicate the usage of the clay only for the walls (both facade and interior) as well as interior details construction. As one of the variants for the interpretation of such anomalies, an approach to understanding the architecture of mega-structures can be applied: when part or sometimes the whole area of the mega-structure was surrounded by vertical wooden-clay constructions, without a roof (Burdo and Videiko 2016; Hofmann *et al.* 2019b). It is also possible that the existing state of the building anomaly at Hariachkivka 3 was influenced by agricultural activity and/or natural erosion processes.

^{14}C dating

From the pit investigated in Trench 3, four ^{14}C dates were successfully obtained, from bones of a large herbivore (Poz-128012) and medium-sized mammals (Poz-128013; Poz-128263 and Poz-128264; Suppl. 1 in Chapter 19, this work, Vol. II). The samples were taken from two stratigraphically consecutive parts of the pit fill (upper and lower part). According to a Bayesian model, the backfilling occurred most probably in the period between 4025 and 3960 BCE (Tab. 6; Fig. 44).

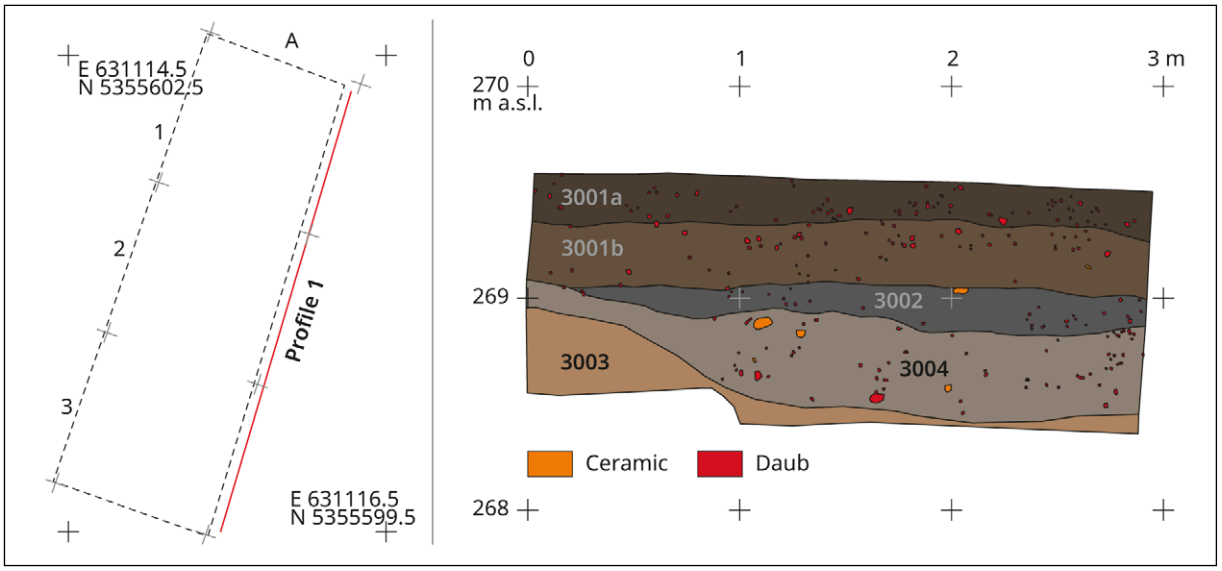


Figure 43 (above). Hariachkivka 3, Trench 3: the configuration of the trench and the location of Profile 1; 3001a, 3001b – Chernozem; 3002 – grey black, yellowish; 3003 – yellow grey; 3004 – grey yellow.

Table 6. Hariachkivka 3: Bayesian model of the backfilling process of the pit investigated in Trench 3. A_{model}=112.1; $A_{overall}$=112.5. All boundary dates BCE and durations in years.

	Dating range 68.2%	Dating range 95.4%	Median	Highest dating probability
Boundary start, lower filling	4073–3993	4236–3982	4046	4025 or 4005
Duration	0–74	0–250	42	20 or 40
Boundary, lower-upper filling	4016–3968	4146–3932	3994	3985
Duration	0–88	0–371	47	25
Boundary end, upper filling	4032–3897	4044–3623	3923	3960

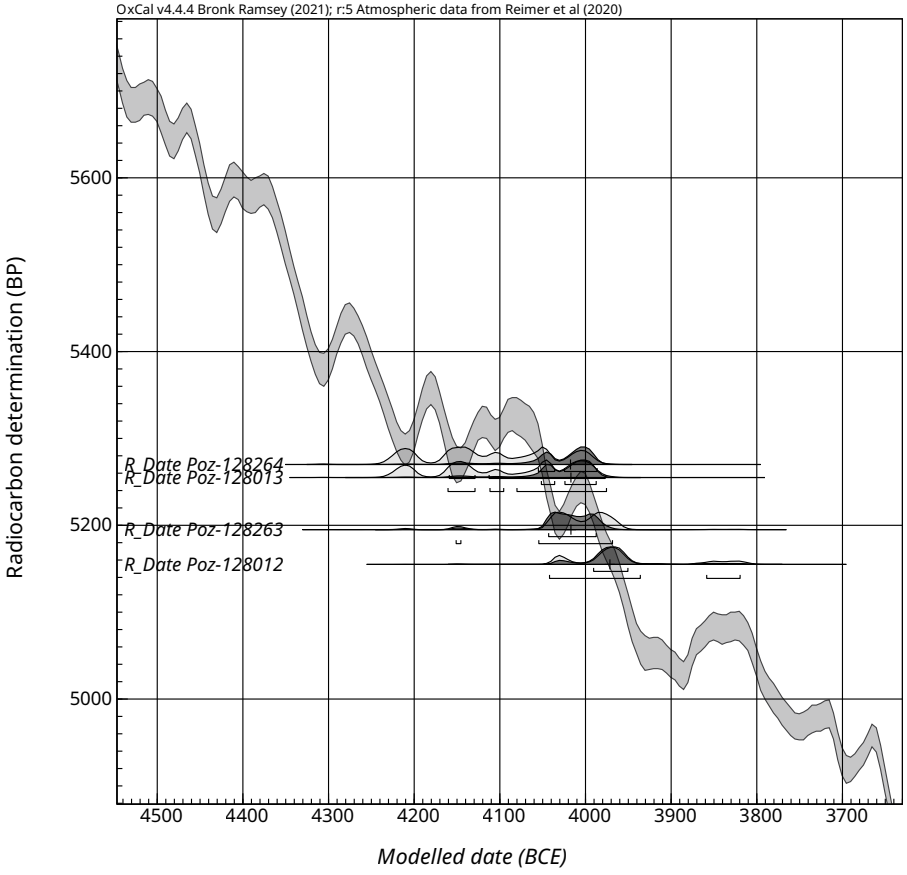


Figure 44. Hariachkivka 3: curve plot of four modelled ^{14}C dates from Trench 3.

Hariachkivka 7

Research history

The site was discovered during fieldwalking of V. T. Zahoruiko in 1993 (Zahoruiko 1993, 7, Fig. 6, Fig. 20: 1–8; Lototska and Ocheretnyi 1997; Zahoruiko and Shumova 1997). In spring 2018 in the joint project between CAU and IA NASU, magnetic scanning of the settlement was conducted. In summer 2019, test excavations of two anomalies were conducted based on the results of the magnetic survey.

Geographical position

The Hariachkivka 7 settlement (48°18'58.2"N, 28°46'08.2"E) is 0.5 km to the east of the south-eastern outskirts of the village of Hariachkivka in the Horodkivka territorial community of the Tulchyn Raion. The settlement occupies a slightly sloping edge of the plateau of the Hariachkivka River left bank (Hariachkivka → Vilshanka → Markivka → Dniester; Fig. 45). The river is to the north-west of the settlement and to the south-west there is a dry valley (arroyo), on the opposite bank of which the Hariachkivka 8 settlement is located. The surface within the Hariachkivka 7 settlement has a mostly western exposition; the average slope is about 7%.

A narrow line of trees goes approximately through the centre of the settlement in a north-east/south-west direction. The northern part of the settlement is currently used as pasture, and is covered with wild grass and small stand-alone trees. The south part of the settlement is separated into several areas for growing annual agricultural crops.

Opposite to the settlement, on the right bank of the Hariachkivka River, is the northern part of the Cherniakhiv culture settlement Hariachkivka 6 (Fig. 46). On the southern edge of the Trypillia culture settlement Hariachkivka 7, at the level of the modern ground surface, Final Bronze Age artefacts were also found, partly located on the territory of the Trypillia settlement. The majority of the Bronze Age artefacts is located to the south. The material found spreads across a total area of 150 × 150 m.

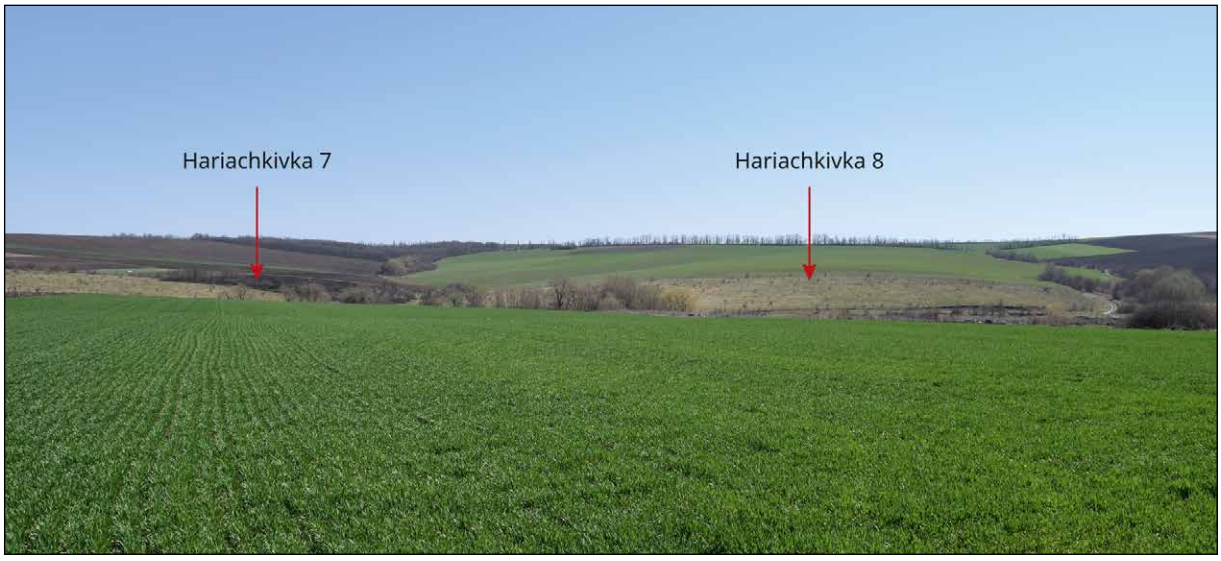


Figure 45. Hariachkivka 7 and 8, view of the sites from the north. Photo taken during the magnetic survey of the sites in April 2018.

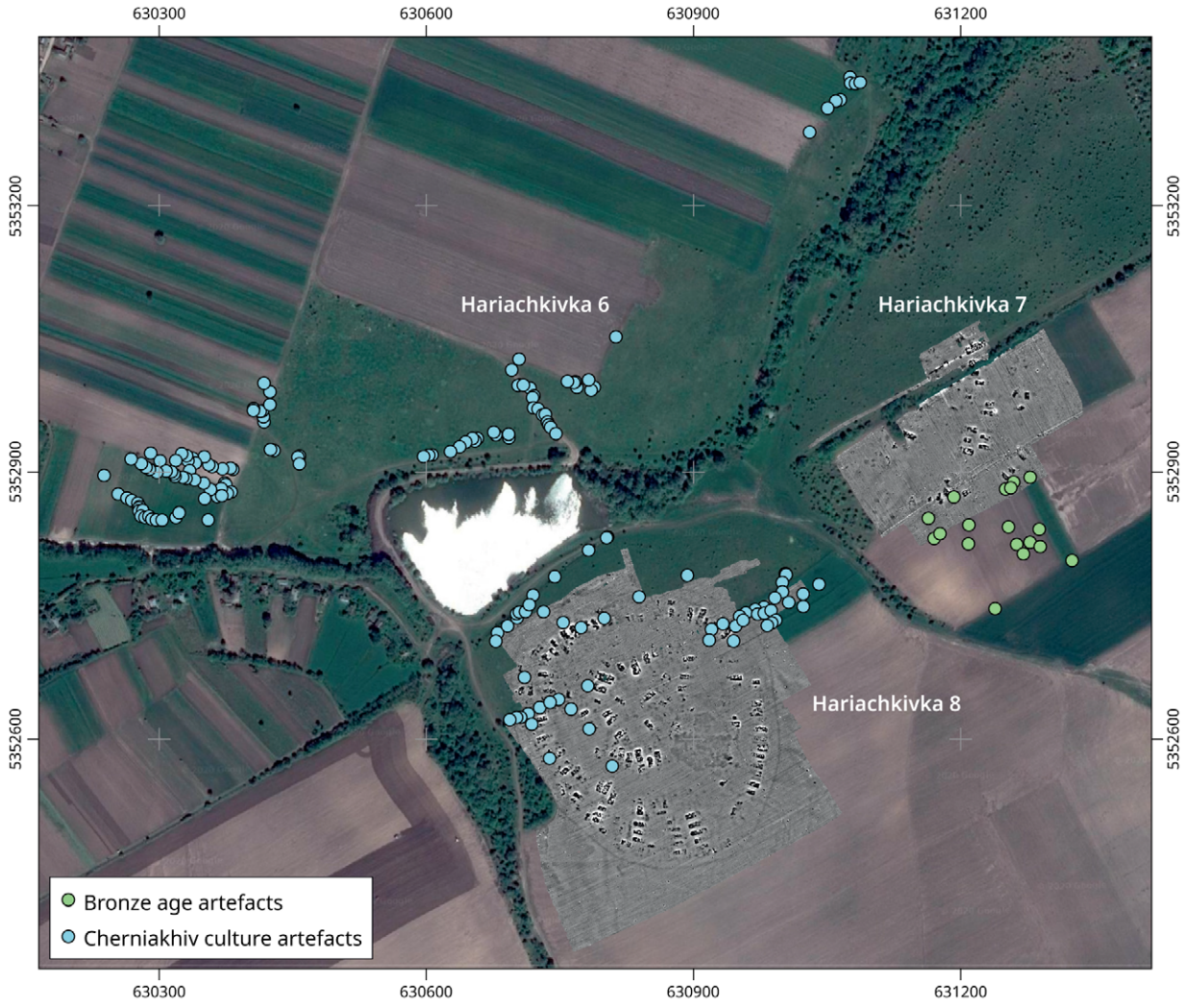


Figure 46. Hariachkivka 6, 7 and 8: position of the sites on the Hariachkivka River; dots display the distribution of the Cherniakhiv and Final Bronze Age artefacts found on the modern surface; magnetic maps (∓ 3 nT) display the location of the Trypillia settlements. Magnetic and GPS data are mapped against the background of the Google satellite image.

Magnetic survey

Magnetic scanning was conducted over an area of 3.8 ha. Anomalies of archaeological features are present on almost all areas of the magnetic map obtained (Figs. 46, 47). The south, east and central parts of the settlement were examined. Considering the location of the features on the magnetic map and the topography of the area, it appears that the area of the settlement is not more than 5.5 ha.

The following categories of magnetic anomalies were found at the Hariachkivka 7 settlement (Fig. 48):

- 20 rectangular anomalies, which represent the ruins of burnt wooden-clay buildings.
- 9 rectangular anomalies of the buildings, which were burnt with less intensity or eroded.
- 2 anomalies of mega-structures.
- 69 anomalies of pits of various forms.

According to the area surveyed, the main structure at the settlement is the arc-like row of buildings. The southern end of the arc is located at the edge of the slope to the dry valley (arroyo). The row is not densely built. It consists of groups of two-four buildings each. There is a 20–32 m wide corridor free of buildings which is parallel to the row on the east. Outside this are two groups of buildings. Each group has three

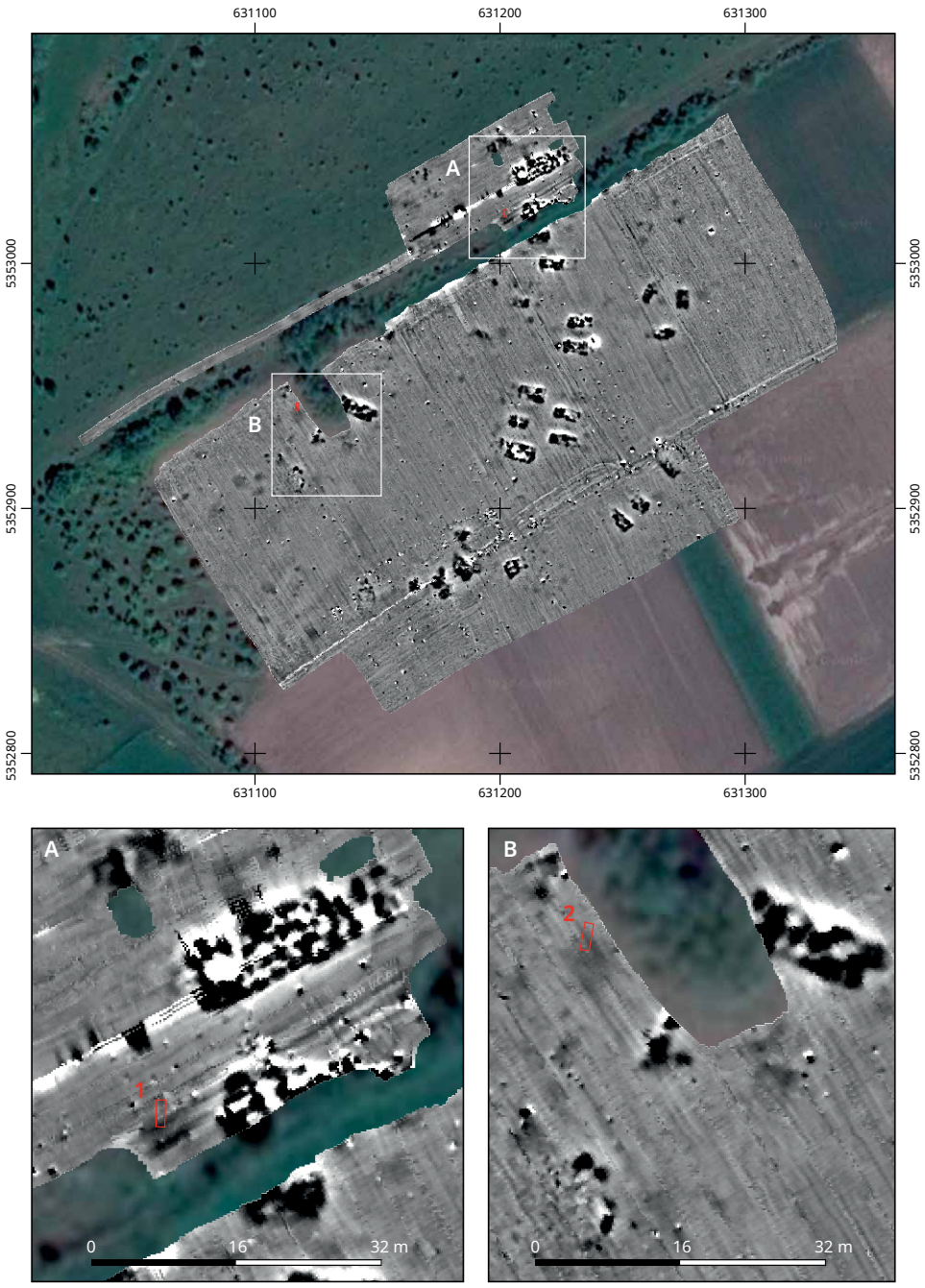


Figure 47. Hariachkivka 7: magnetic map (∓ 3 nT) of the site and its details against the background of the Google satellite image; (A) location of Test Trench 1 on the pit next to mega-structures, north-eastern part of the site; (B) location of Test Trench 2 on the pit in the south-western part of the site.

buildings. The long axis of five of the six buildings is located in a radial direction. In the central part of the settlement, at a distance 5–10 m west of the buildings of the arc-like row, there are also two groups of buildings, the long axis of which has a radial direction. In the western corner of the magnetic map another group of three buildings with a different vector is located.

Four anomalies of the buildings have a longitudinal spatial division into two parts (see the description of the magnetic plan of the Zabolotne settlement). The first one, the entrance part, covers about 1/3 of the building, the second is the main room and occupies about 2/3 of the building. Based on this, we can say that the entrance to the buildings of the arc-like row is located to the east, while the entrance to the buildings located to the west and east of the arc is from the west.

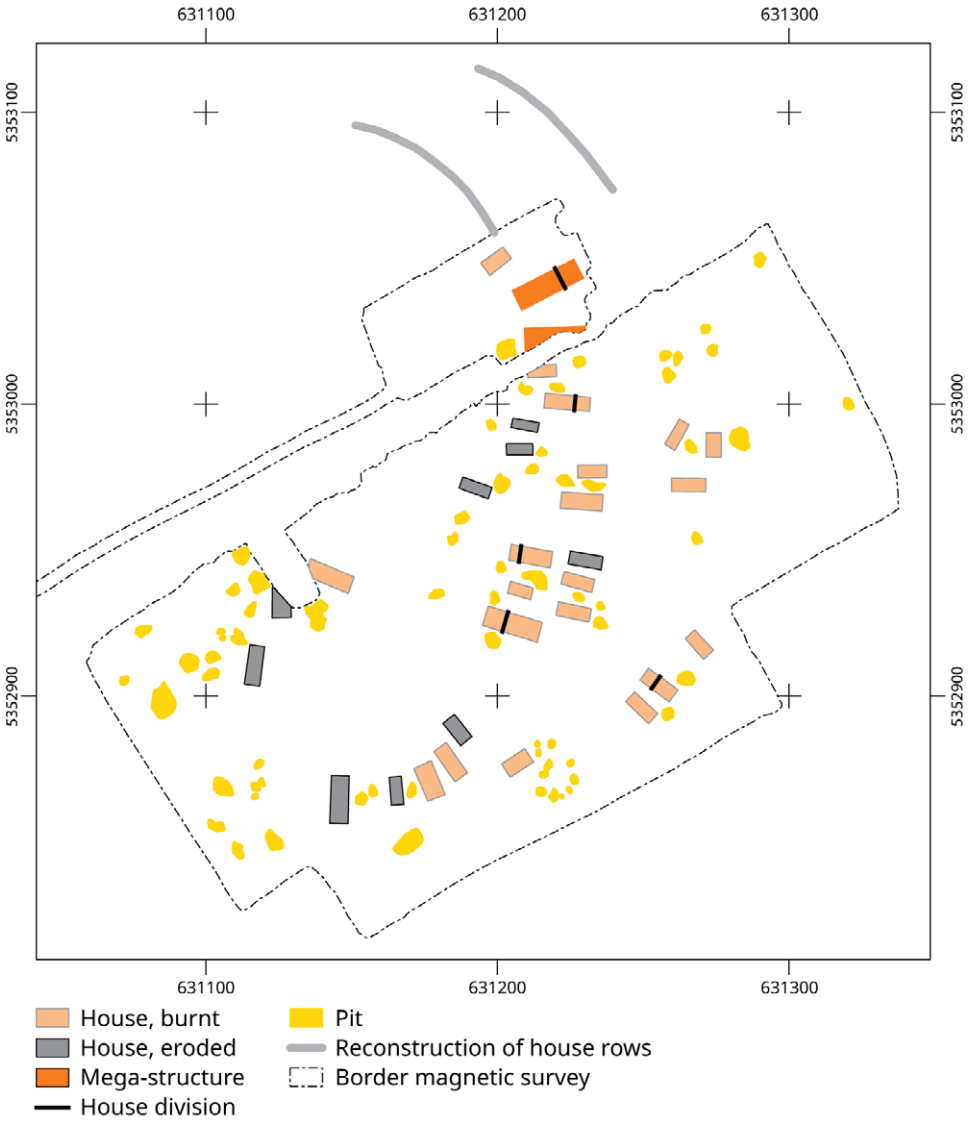


Figure 48. Hariachkivka 7: interpretation of the magnetic features.

The area of the anomalies which were interpreted as buildings varies from 30 to 136 m² (Tab. 7; Fig. 49). The same percentage of buildings (ca. 46%) have areas of up to 50 m² or 51–100 m². The largest regular building at the settlement is 136 m².

In the north-eastern part of the settlement, within the arc-like row there are two large buildings. The territory of the northern one has been totally examined; it is 25.0 × 7.5 m in size, its area is 187.5 m². The azimuth of its long axis is 63°. Only the northern part of the southern building has been examined. Based on this, its size is approximately 21.0 × 7.4 m (155.4 m²). The azimuth of the long axis of the building is 85°. The exceptional large area of the buildings and their location at the settlement allows us to consider them as mega-structures.

The anomalies of the pits at the settlement are located near the buildings, mostly along the long side of the buildings, or localised in groups at a distance from the buildings. The biggest cluster of pits anomalies is in the western part of the magnetic plan, on the area sloping to the dry valley (arroyo). Another group of pits is located in the southern part of the settlement, on the territory of the corridor free of buildings. Two anomalies of the pits are located at a distance 40 m to the east of the outermost buildings of the settlement. It is possible that some of the pit anomalies in

Area (m²)	Number of buildings	Percentage of buildings (%)
30–50	13	46.43
51–100	13	46.43
101–136	2	7.14
30–136	**28**	**100**

Table 7. Hariachkivka 7: number and percentage of buildings at the settlement grouped by area in steps of 50 m².

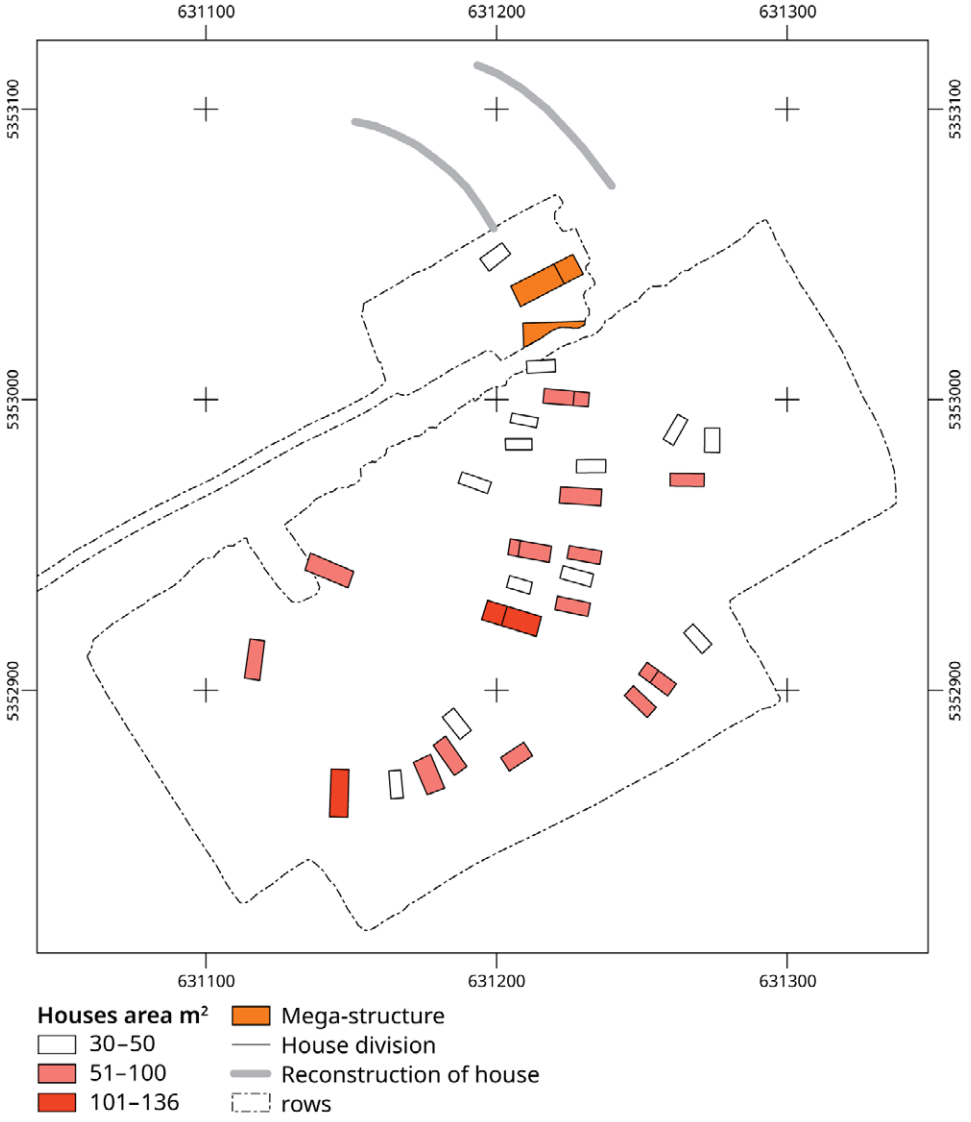


Figure 49. Hariachkivka 7: the location of the houses categorised by their size.

the southern part of the settlement may be date to the Final Bronze Age, for example the group of pits in the corridor free of buildings, considering their small sizes.

Therefore, the planning of the settlement is based on the arc-like structure, which represents the traditional tendency of the circular design of the Trypillia settlements. One arc-like row with two mega-structures in the north-eastern part have been clearly seen. It was probably planned as the inner circular row of the settlement. A corridor free of buildings, the prototype for which is the ring-corridor, is also present. To the east of the corridor there are anomalies of buildings and pits, which represent an attempt to create the outer circle of buildings. The area of the settlement inside the inner circle is mostly free of buildings.

Excavation

The test excavations at the Hariachkivka 7 settlement were conducted on two features, the locations of which were chosen after carrying out a magnetic survey (Fig. 47). The distance between the trenches is 113 m.

Trench 1, pit

Trench 1, with an area of 3 × 1 m, was investigated in order to examine the northern part of an anomaly, which was interpreted as a pit. The anomaly is 8.3 x 7.2 m in size. It is located 2.6 m to the west of the building anomaly within the arc-shaped row. This is the southern one of two buildings with a large area, which we consider to represent a mega-structure.

In the central and northern part of the trench the deepened feature was examined. Its deepest part is at the level of 254.06 m asl. The bottom of the pit within the examined area is mostly flat, slightly curved, and the wall is inclined (Fig. 50). Two contexts (1004a and 1004b) seem to be connected with pit filling. The natural bottom part (1004b) was filled with yellowish black-grey soil with a yellow shade and contained a large amount of ceramic pottery and daub fragments up to 15 cm in size. The layer also contained small fragments of charcoal, stones and bones (<10 cm), and flint fragments. The next context (1004a), which stratigraphically lies above the previous one, contained a smaller amount of daub, stone and bone fragments. The artefacts were found in the greyish-black layer of soil. The maximum thickness of both contexts is 50 cm. It appears that the initial depth of the pit did not exceed this. The pit was dug in the yellow-brown loam layer (1003).

Two-thirds of the daub from Context 1004 contained an admixture of chaff, the rest an admixture of sand. Most of the fragments are amorphous; only two first-type daub fragments had one flat surface. Five more daub pieces of the same type had imprints of split wood, meaning that the daub fragments in the trench seem to be elements of wooden-clay building.

Above the pit filling there is a black-grey Chernozem layer (1002), 34–51 cm thick, which contains small, single fragments of daub and ceramics. A fragment of an anthropomorphous figurine was also found in the layer. The upper layer of the trench is the grey-black Chernozem layer (1001), which is analogical to the filling of Layer 1002. Its thickness does not exceed 24 cm.

Therefore, the part of the shallow pit near the mega-structure was investigated. The bottom of the pit was compactly filled with artefacts, most of which are

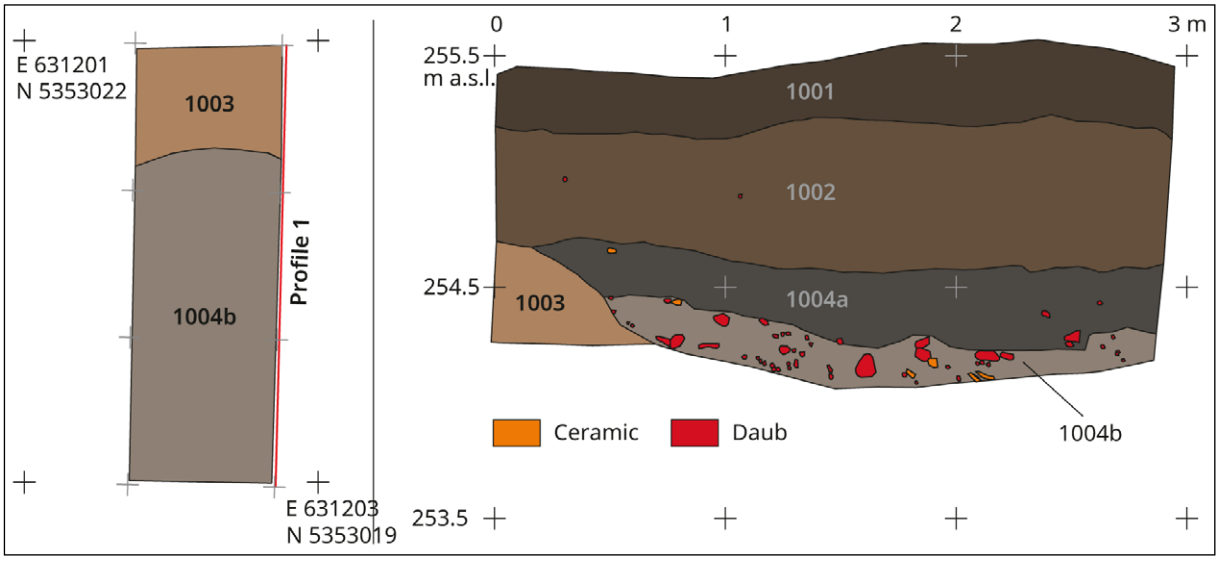


Figure 50. Hariachkivka 7, Trench 1: the border of the pit (1004b) at the level of Planum 1 (254.23–254.25 m asl) and the location of Profile 1 (left drawing); Profile 1 (right drawing): 1001 – grey-black, Chernozem; 1002 – black-grey, Chernozem; 1003 – yellow-brown; 1004a – black, greyish; 1004b – black-grey, yellowish.

fragments of pottery and daub from wooden-clay building. The large amount of flint artefacts found in the test trench should be noted.

Trench 2, pit

Trench 2 measured 1 × 3 m and was positioned in order to examine the northern part of the pit anomaly located in the west part of the magnetic plan. The anomaly is 7.4 x 5.5 m in size. The anomaly refers to the features which were located in the area surrounded by the arc-shaped building row. The pit anomalies are mostly located here.

Part of the pit was examined in the central and southern quadrats of the trench. Only one context (2003) represents the anthropogenic filling of the feature (Fig. 51). It is a 5–14 cm thick layer of yellow-black soil, the lowest spot of which is 249.93 m asl deep. The layer contains a small amount of daub fragments and some bone and ceramics pottery fragments. Most of the artefacts are 10 cm in size; some are 20 cm. Single fragments of flint and stone are also found in the layer. The artefacts are in

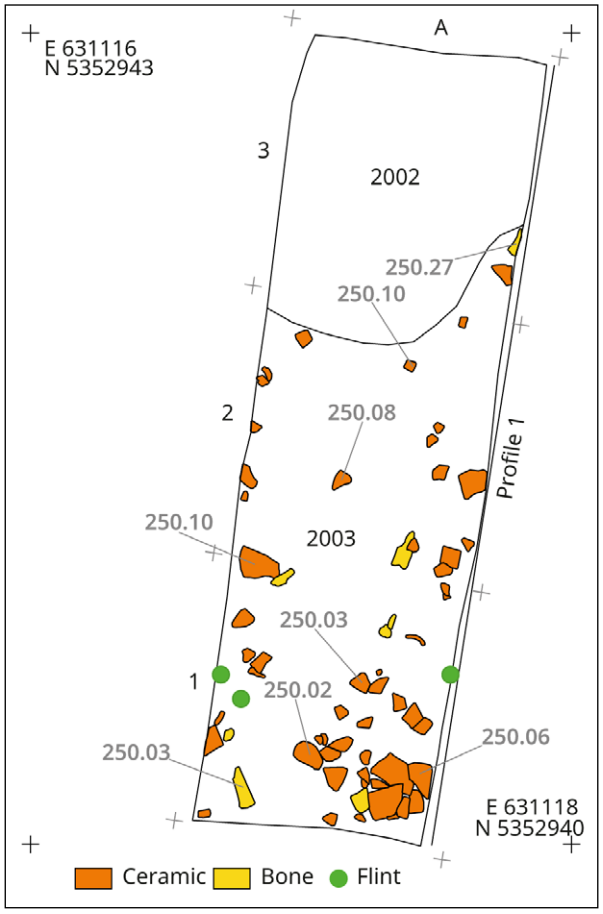


Figure 51. Hariachkivka 7, Trench 2: the character of the pit filling (2003) at the level of Planum 1, in terms of the artefacts it contained, and the natural soil (2002) outside the pit. Location of Profile 1.

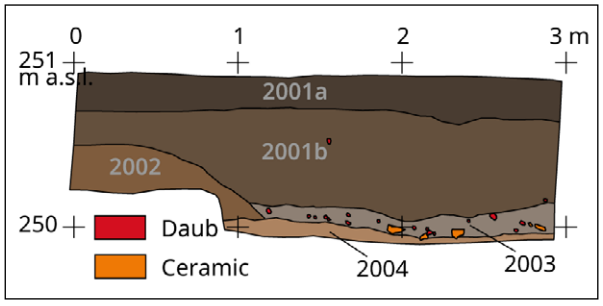


Figure 52. Hariachkivka 7, Trench 2, Profile 1: 2001a – grey-black, Chernozem; 2001b – black-grey, Chernozem; 2002 – grey-yellow; 2003 – yellow-black; 2004 – yellow-brown.

general concentrated in the southern quadrat of the trench, in the central part of the pit. Below Context 2003 is a layer of natural yellow-brown soil (2004; Fig. 52). The pit was dug in the natural grey-yellow soil (2002), covered by Chernozem (2001). The thickness of the Chernozem layer above Context 2002, outside the pit, is no more than 33 cm, while above this the filling of the pit is up to 67 cm. Small amount of the burnt clay crumb and single ceramics fragments of pottery are found in Context 2001. The upper, ploughed layer of Chernozem (2001a) is grey-black, the lower (2001b) is slightly darker.

Therefore, the initial depth of the pit was probably 45 cm; dug in order to acquire soil from Layer 2002. Considering the border between Contexts 2002 and 2004 in the northern part of the trench, we can assume that the pit was not cut into Context 2004, but rather ended at its boundary. The bottom of the pit is flat. Context 2003 indicates that only the bottom part of the pit is filled with a small amount of domestic waste. The magnetic plan shows that the pit is not oval or round; its contours are amorphous. This is also confirmed by the excavations and is clearly visible during documenting the contours of the pit on the Planum 1 (Fig. 51).

^{14}C dating

From the pit investigated in Trench 2, three ^{14}C dates were successfully obtained from bones of cattle (Poz-128014 and Poz-128145) and a large ruminant (Poz-128143; Suppl. 1 in Chapter 19, this work, Vol. II). The samples were taken from the bottom of the pit fill (Feature 2003). According to a Bayesian model, the backfilling occurred with the highest probability during the period between 4235 and 4050 BCE (Tab. 8; Fig. 53).

Hariachkivka 8

Research history

The site was initially discovered during fieldwalking by V. T. Zahoruiko in 1993 (Zahoruiko 1993, 7–8, Fig. 6, Fig. 12: 20–40; Lototska and Ocheretnyi 1997; Zahoruiko and Shumova 1997). In spring 2018 during the cooperative work between CAU and IA NASU the magnetic survey of the settlement was conducted. In summer 2019 test excavations of several anomalies were conducted based on the results of the magnetic survey. Some results are already published (Rud *et al.* 2022).

Geographical position

The Hariachkivka 8 settlement (48°18’49.1”N, 28°45’54.7”E) is located to the east of the outermost buildings on the south-eastern outskirts of the Hariachkivka village of the Horodkivka territorial community of the Tulchyn Raion. The settlement occupies the slightly sloping promontory-like edge of the plateau on the left bank of the Hariachkivka River (Hariachkivka → Vilshanka → Markivka → Dniester; Figs. 45, 46). The river is to the north of the settlement; the dry valley (arroyo) is located to the north-east on the opposite bank of which the Hariachkivka 7 settlement is located. The territory of the settlement from the western side is also enclosed by the arroyo. The ground surface within the Hariachkivka 8 settlement has a mostly north-west exposition and the average slope is approximately 7%.

The northern part of the settlement is turfed and currently used as pasture, covered with wild grass and small stand-alone trees. The south and central parts of the settlement are used for growing annual agricultural crops. The western part of the settlement is damaged by the small quarry.

	Dating range 68.2%	Dating range 95.4%	Median	Highest dating probability
Boundary start lower filling	4322–4096	4680–4054	4236	4235
Duration	0–265	0–985	158	185
Boundary end upper filling	4195–3985	4237–3609	4061	4050

Table 8. Hariachkivka 7: Bayesian model of the backfilling process of the pit investigated in Trench 2. A_{model}=101.2; $A_{overall}$=101.8. All boundary dates in BCE, durations in years.

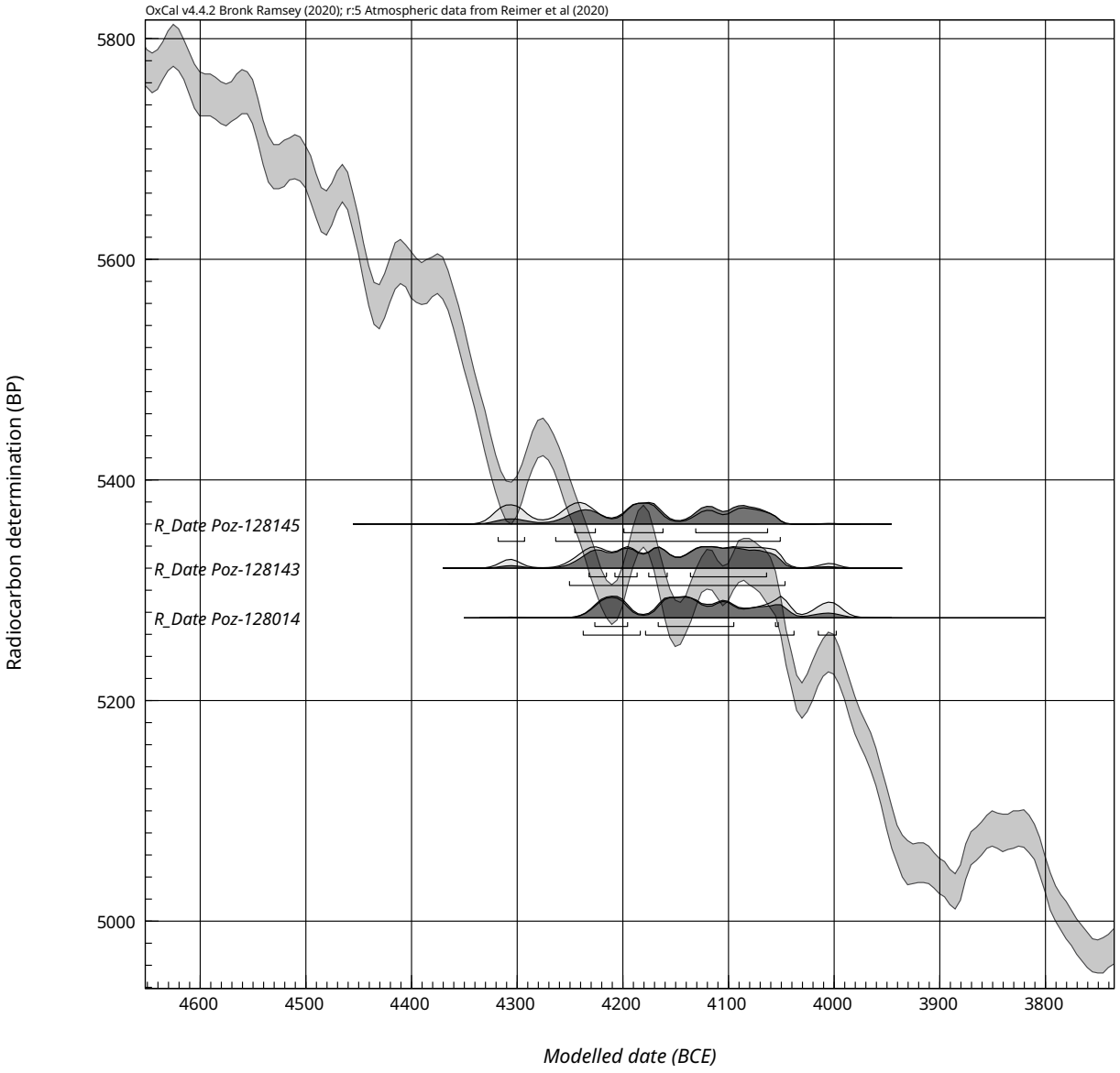


Figure 53. Hariachkivka 7: curve plot of three modelled ^{14}C dates from Trench 2.

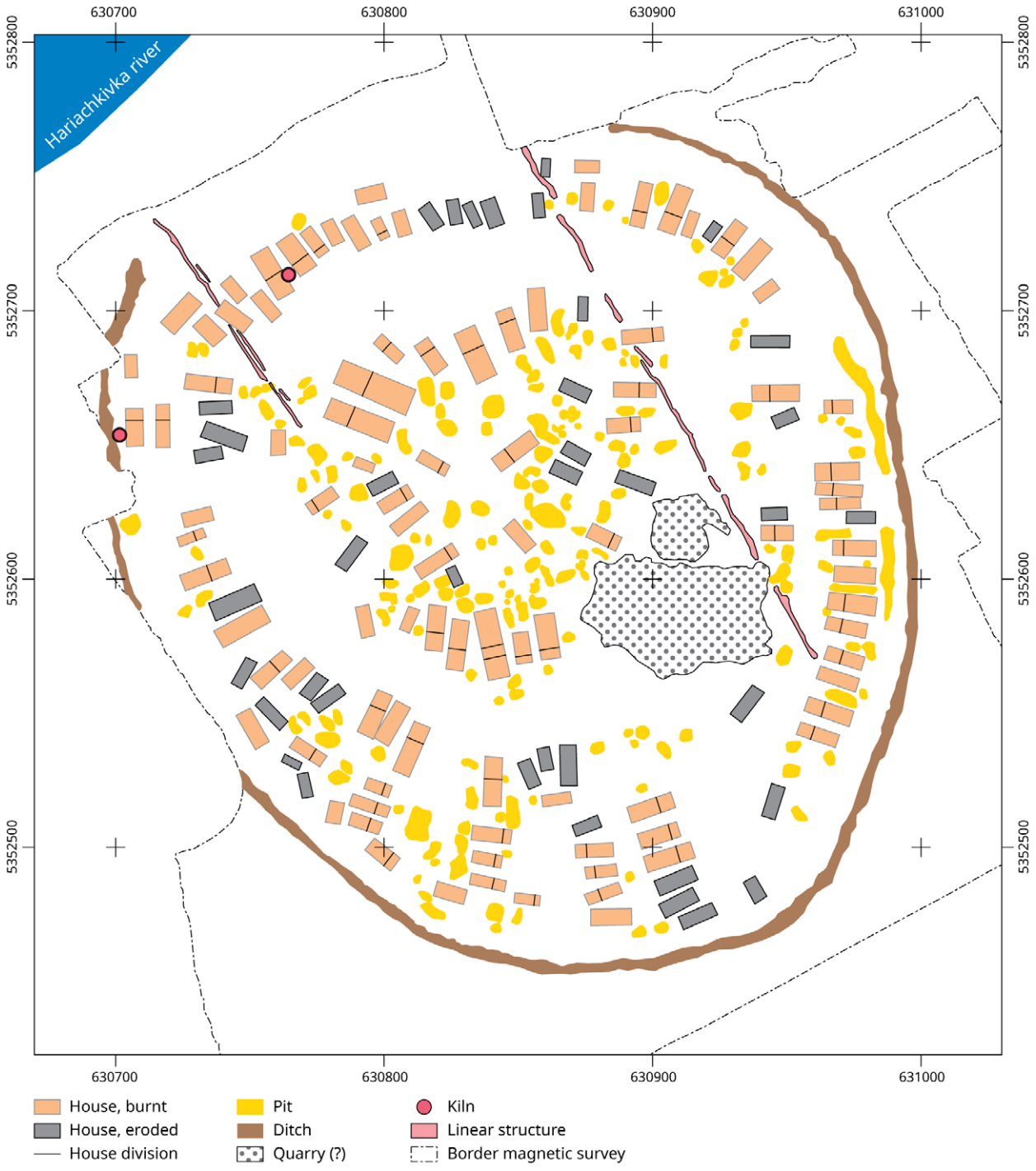
Opposite the settlement, on the right bank of the Hariachkivka River, is the southern part of the Cherniakhiv culture settlement Hariachkivka 6. On the northern part of the Trypillia culture settlement Hariachkivka 8, at the modern surface level, materials of the Cherniakhiv culture were also found. The total area of material spreads over 400 × 220 m.



Figure 54. Hariachkivka 8: magnetic plan (∓ 3 nT) of the site against the background of the Google satellite image.

Magnetic survey

The magnetic survey was conducted over an area of 10.9 ha. As a result, we have acquired the complete picture of the settlement which has an area of 7.5 ha (Fig. 54). There are several categories of magnetic anomalies found at the Hariachkivka 8 settlement (Fig. 55):



- 96 rectangular anomalies of burnt ruins of wooden-clay buildings.
- 39 rectangular anomalies of buildings which were burnt with less intensity or eroded.
- 195 anomalies of different-form pits.
- 2 round anomalies of kilns.
- 2 areas of possible clay sources.
- The linear anomaly of the ditch.
- The anomalies of two linear structures.

Figure 55. Hariachkivka 8: interpretation of the magnetic features.

The settlement is 330 × 290 m large in an oval form stretching from the promontory direction in a north-west/south-east direction. The settlement is surrounded by the linear anomaly of the ditch. The width of the anomaly varies in different places from 2 to 5 m. The western part of the ditch, approximately 82 m long, is destroyed by the quarry. The north-west part of the ditch lies partly outside the magnetic survey, however the scanned areas allow an understanding of its direction. The clear magnetic anomaly of the ditch is visible in the south-western and eastern part of the settlement. However, in the south-east, in the topographically highest part of the settlement, the anomaly of the ditch over an area 30 m in length is hardly visible. In the northern part of the settlement the ditch did not exist, which means that the settlement was open to the river. The total length of the ditch was at least 805 m.

The core planned structures are the two concentric rows of buildings with a ring-corridor between them. The inner row has dense and clear structure in the northern and southern parts. In the eastern and western parts the location of the buildings appears to be unsystematic. The density of the buildings is low along the row. Inside the row there are straight line of buildings or stand-alone buildings. Generally the inner space of the row is not built densely, but is occupied by a large number of pits.

The outer concentric row is 235 × 250 m in size. All of it, except the eastern part, is densely and systematically occupied by buildings. In the south-eastern part of the row, there is a 60 m wide space free of buildings (the site entrance), which corresponds to a barely visible area of the ditch anomaly. The long axis of all the buildings of the row has a radial direction, excluding one building on the edge of the area free of buildings.

The compact location of the buildings has a row of houses which is located to the east of the eastern part of the outer row, which is not built densely. The space outside the outer row, to the south and south-west from it, is mostly occupied by the short (up to six buildings) radial rows of buildings. Some houses to the north and north-west of the outer row are perpendicular to the buildings of the row.

62 out of 96 buildings, which are the ruins of burnt wooden and clay houses, have a lengthwise spatial division of the anomaly into two parts (see the description of the magnetic plan of the Zabolotne settlement). The first room, the entrance, occupies 1/3 of the building area, the second, the main room, occupies 2/3 of the building area. Such cases are typical for the synchronous settlement of the Kryzhopil region. One of the anomalies of the buildings in the southern part of the inner circle appears to have the division into three parts. Such examples are also known at settlements (Ternivka, Vilshanka, *etc.*) of the region.

The areas of the anomalies which were interpreted as buildings range from 22 to 290 m^2. In the location of the buildings grouped by area in steps of 50 m^2 (Tab. 9) the following features were noted. The buildings with an area of up to 100 m^2 are located all over the settlement (Fig. 56). The most common (57%) are buildings with an area of 51–100 m^2. 17% of the buildings measure from 101 to 150 m^2. They are mostly located within the circular rows or near the site entrance. They can also be present within the row of the buildings to the east of the outer row, probably

Area (m^2)	Number of buildings	Percentage of buildings (%)
22–50	31	22.96
51–100	77	57.04
101–150	23	17.04
151–200	1	0.74
201–250	2	1.48
290	1	0.74
22–290	**135**	**100**

Table 9. Hariachkivka 8: number and percentage of buildings at the settlement grouped by area in steps of 50 m^2.



Figure 56. Hariachkivka 8: location of the houses categorised by their floor size.

as a result of the low density of the buildings located in the eastern part of the outer row. The buildings with an area of over 150 m² are located only within the inner row. The building with an area of 290 m² is the largest in the settlement. It is located in the north-western part of the row. Its unique size is one-third larger than the next largest building in the settlement – 214 m². Considering this, we suggest it should be viewed as the mega-structure. The building with an area of 204 m² is located to the south of it.

The ring-corridor is mostly 21–30 m wide; only in its south-eastern part is it approximately 55 m wide. Generally, the corridor is free of buildings. Of interest

is the group of pits and the building which are located in the north-western part of the ring-corridor. It appears not to be coincidental that near these features the two biggest buildings of the settlement are located, as part of the inner circle, and where also the change of the course in the outer circle occurred.

The low-density building of the eastern parts of the inner and outer rows has been already mentioned. This seems to be due to the proximity of two features in the eastern part of the ring corridor. The first, southern, feature has an area of 0.23 ha (approximately 68 × 38 m) and is clearly part of the ring-corridor. The northern and north-western sides are straight, with a radial direction. To the north of the first is another feature with an area of 0.04 ha (approximately 20 × 20 m), which occupies the central part of the ring-corridor. The distance between the features is 1–3 m. The nearest buildings are 4–10 m away from the features. There are no buildings at all in the concentric rows sections opposite the southern feature. The features are formed of a number of small anomalies, with a magnetic flux density value of about 1 nT.

Considering the clear location of the southern feature, within the ring-corridor, and the absence of the buildings in the concentric rows opposite to it, we assume that this feature was built at the initial stages of functioning/planning of the settlement. The northern feature seems to have functioned later – during the existence of several buildings, as parts of the inner and outer circles. The magnetic flux density value of the pits, ditch and unidentified feature anomalies in the eastern part of the ring-corridor is the same – about 1 nT. Based on this, we assume that these atypical large features are deepened and, considering its size, that this area could have been used to mine clay for collective use.

Most of the pits are located near the edges of the buildings, opposite to the entrance, or along the longitudinal parts of the buildings. The shape of the pits mostly resembles ovals or circles. Using the row of buildings to the east of the outer concentric row as an example, we can see the presence of 'long' pits, 1.5–2.6 m wide and 13–55 m long. The shorter ones are located between the buildings, and the longer ones are near the edges of the buildings, opposite to the entrance, parallel to the row of buildings and ditch. The small number of pits in the northern part of the settlement can be explained by the low definition of the magnetic plan, which does not allow us to distinguish the pit anomalies, which usually have the magnetic flux density value of about 1 nT.

Three oval anomalies were found on the magnetic plan, the maximum flux density value of which varies between 20 and 40 nT. The sizes of the anomalies are 2.7 x 2.3 m, 3.1 x 3.0 m and 4.5 x 3.6 m. Before the beginning of the field season in 2019, these anomalies were interpreted as kilns for ceramics firing and it was decided that they would be examined via excavation. As the result it was discovered that the first two anomalies are indeed kilns, however they belong to the Cherniakhiv culture of the Late Roman Age. The third anomaly is the ruins of the Trypillia culture building. Detailed information on the research results are given below.

There are two linear structures, which are displayed on the magnetic plan. The eastern one is 219 m long and 0.8–2.5 m wide in various places. It starts at the south-west part of the inner concentric row and goes south-west to the river valley. The western structure consists of two parallel linear anomalies 1.2 m away from each other. The total length of the structure is 95 m, the width of the anomalies is 0.4–2.1 m. The structures are parallel, 120 m apart from each other. The western one starts from the group of pits in the north-western part of the ring-corridor and goes outside the settlement to the river valley as well. Considering the fact that the southern part of the Vinnytsia region is the territory on which irrigation systems were used until recently, we identify the described structures as the traces of such systems.

Therefore, the settlement is planned in two concentric rows with the ring-corridor between them. The centre of the settlement is partly built and mostly occupied by the pit anomalies. Outside the outer row, the buildings are located in a long row (eastern part), parallel to the buildings of the circle or short radial lines (southern

and south-western parts). Within the ring-corridor anomalies of features are mostly absent. The exception is the north-western part with several pits and the building. It appears that the presence of these features is connected to the nearby location of the mega-structure in the inner circle. However, it is important to remember that this territory was occupied in the Late Roman Age as well. In other words, not all of the anomalies, especially in the northern part, may belong to the Trypillia period. However, the specifics of the north-western part of the settlement is emphasised by the change of course of the outer circle buildings.

The chronology of two atypical features in the south-eastern part of the settlement is out of question, since their location within the ring-corridor indicates that they belong to the Trypillia settlement. Our preliminary interpretation is that they are sources of clay for collective use. The importance of their location in this particular part of the settlement may have influenced the location of the mega-structure in the north-western part of the settlement, instead of a more typical eastern or north-eastern location (Hofmann *et al.* 2019b). The location of these features also seems to have affected the density of the buildings in the eastern part of outer circular row. The role of this part of the row probably plays the densely-built row to the east of the circle. The site entrance remains in the southern area that is connected to the path to the flat parts of the promontory and plateau.

Excavation

As a working hypothesis, three magnetic anomalies on the geophysical plan of the Hariachkivka 8 settlement were interpreted as possible kilns for pottery firing. This assumption was tested by excavation. The north-western anomaly was completely investigated by Trench 1, part of the northern anomaly by Trench 4, part of the eastern anomaly by Trench 5 (Fig. 57). Test excavations were also conducted at the settlement of the other important feature. This is the anomaly of an elongated pit next to the anomaly of the building which was interpreted as a mega-structure (Trench 3). Part of the other pit anomaly which is located near the edge of the other building was also excavated (Trench 2). Overall five trenches with the total area of 113 m^2 were located at the settlement.

Trench 1, Trypillia wood-clay building and a ditch, Late Roman Age pottery kiln and a neighbouring pit

The main goal of Trench 1 was the excavation of the round magnetic anomaly 2.7 x 2.3 m size, which had been interpreted as the Eneolithic kiln prior to the examination (Fig. 57). This interpretation was based on the anomaly's location, which in our opinion fits a Trypillia settlement structure. The anomaly was located at the north-west end of the settlement 1.4 m to the west of the building of the settlement that was the farthest outside the outer row. The building is rectangular, 14 x 6.5 m in size. To the east of it is another building. The long axis of both buildings is directed north-south, perpendicular to the long axis of the buildings of the row. The course of the circle near these two buildings has moved towards the centre of the settlement, which could indicate the important role of these buildings in the life of the settlement. The magnetic scanning of the territory to the west of the kiln was not carried out, as this terrain is thickly covered with bushes. Thus, the picture of the ditch surrounding the settlement is not complete. It appears that it was located at least 1.5 m to the west of the kiln.

According to the initial interpretation, the kiln anomaly along with two buildings were considered as a ceramic production complex. However, the borderline location of the kiln, lying within the ditch-surrounded area, only supported such an interpretation. An analogical location on the edge of the settlement, within the

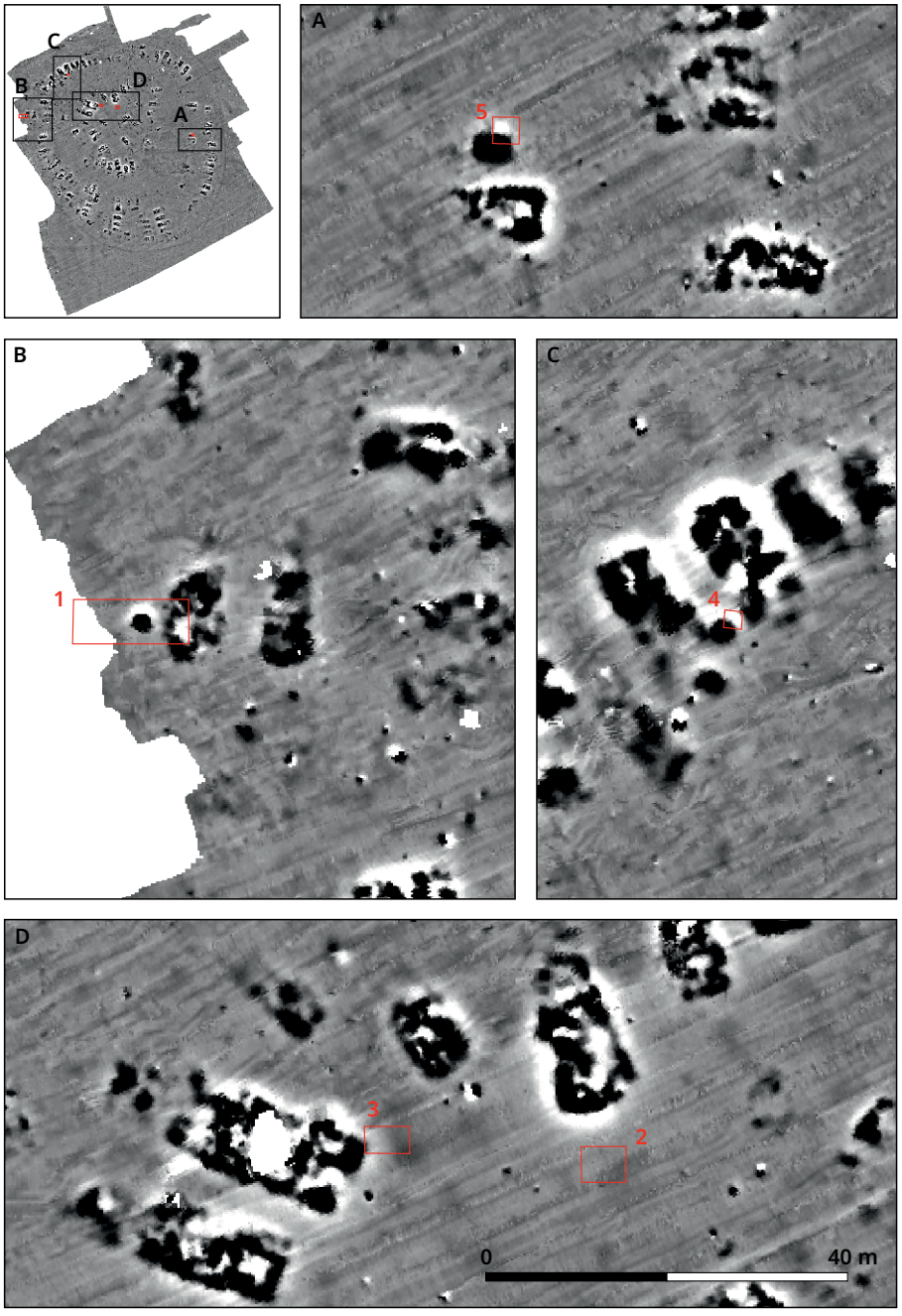


Figure 57. Hariachkivka 8: details of the magnetic map with locations of the trenches; (A) part of the eastern side of the site and location of Test Trench 5; (B) south-western part of the settlement with anomalies of the ditch, kiln and buildings outside the outer row, and location of Trench 1; (C) anomaly of the kiln between the buildings of the outer row in the northern part of the site, and location of Trench 4; (D) south-western part of the inner row with the anomalies of possible mega-structures, and location of Trenches 2 and 3.

ditch-surrounded area, also has a kiln in the Stolniceni 1 settlement which was examined in 2016 (Țerna *et al.* 2017).

Thus Trench 1, 13 x 5 m (Fig. 58), examined the kiln anomaly in full and the building and ditch in part. The trench is located on the inclined area, the difference in height of the modern surface in the long axis of the trench is 1.5 m, sloping down on the west.

Our hopes for digging the Trypillia kiln did not pay off, as while examining it we discovered that this feature, as well as the nearby pit, belonged to the Cherniakhiv culture of Late Roman Age. The results of the kiln excavation have been published (Rud *et al.* 2022). The circular kiln consisted of two vertical chambers, divided by a conditioning grill (Fig. 59). In the middle of the lower chamber there is a round stand, which supported the conditioning grill. The lower chamber was connected



Figure 58. Hariachkivka 8, Trench 1: photo taken during exploration of the features. View from the west.

to the pit near the kiln by a channel. Such kilns are widely found in this culture (Shultse and Liubichev 2019).

The building and the ditch are the only Trypillia features in Trench 1. The centre of the western part of the trench was not examined but preserved; the deepening of the ditch (1010) was found in the north-western and south-western parts of the trench. On the latter the ditch length is 2.18 m, on the former it is 76 m. No clear ditch-deepening was found near the northern wall, which indicates the decline of its deepening in a northerly direction. The ditch outlines are found at a depth of 244.1 m asl (Fig. 60). At this level its width in the southern part is 1.7 m, to the north it narrows to 95 cm. From the southern wall of the trench the ditch goes in a north/north-east direction; later its course changes to north/north-west. At a depth of 244.07–244.13 m asl in the southern part of the ditch filling, several fragments of ceramic and daub, as well as a bone were found. The artefacts are up to 10 cm in size.

The bottom is U-shaped, the central part of the bottom in Profile 3 (Fig. 60) is at a depth of 244.00 m asl. In this profile, 22 cm of ditch depth were documented. It is filled with grey-black, yellowish soil. The ditch is dug in the natural layer of dark-yellow clay (1013; Fig. 61). The deepening of the ditch is covered by a bioturbated and mixed layer of grey-black soil (1006 and 1008) 32–41 cm thick, which mostly contained Late Roman Age artefacts. Above this is the Chernozem layer (1001) 24–28 cm thick, which is the top layer within the trench.

The burnt clay cluster (1009, 1015) of the building ruins is spread 1.8 m wide in the eastern part of the trench (Fig. 62). The highest areas of the building ruins are at the level of 245.61–245.74 m asl along the eastern wall of the trench. In the western direction there is a decline of the level of building ruins down to 245.35 m asl. The building is covered by the Soil Levels 1006 and 1001.

The building ruins were not disassembled, but some construction aspects of the building were examined and its preservation level was determined. The daub is located in two levels. The upper layer (1009) over the whole area examined is substantially damaged by agricultural activity. However, in some areas, mostly in the western part, which is covered by a thicker soil layer (Contexts 1006 and 1001), the upper layer of daub is preserved. It is represented by mostly amorphous fragments of daub, some fragments with one flat side, or imprints of split wood 2–4 cm wide. The thickness of the flat fragments is 2–3 cm. The lower layer (1015) is represented

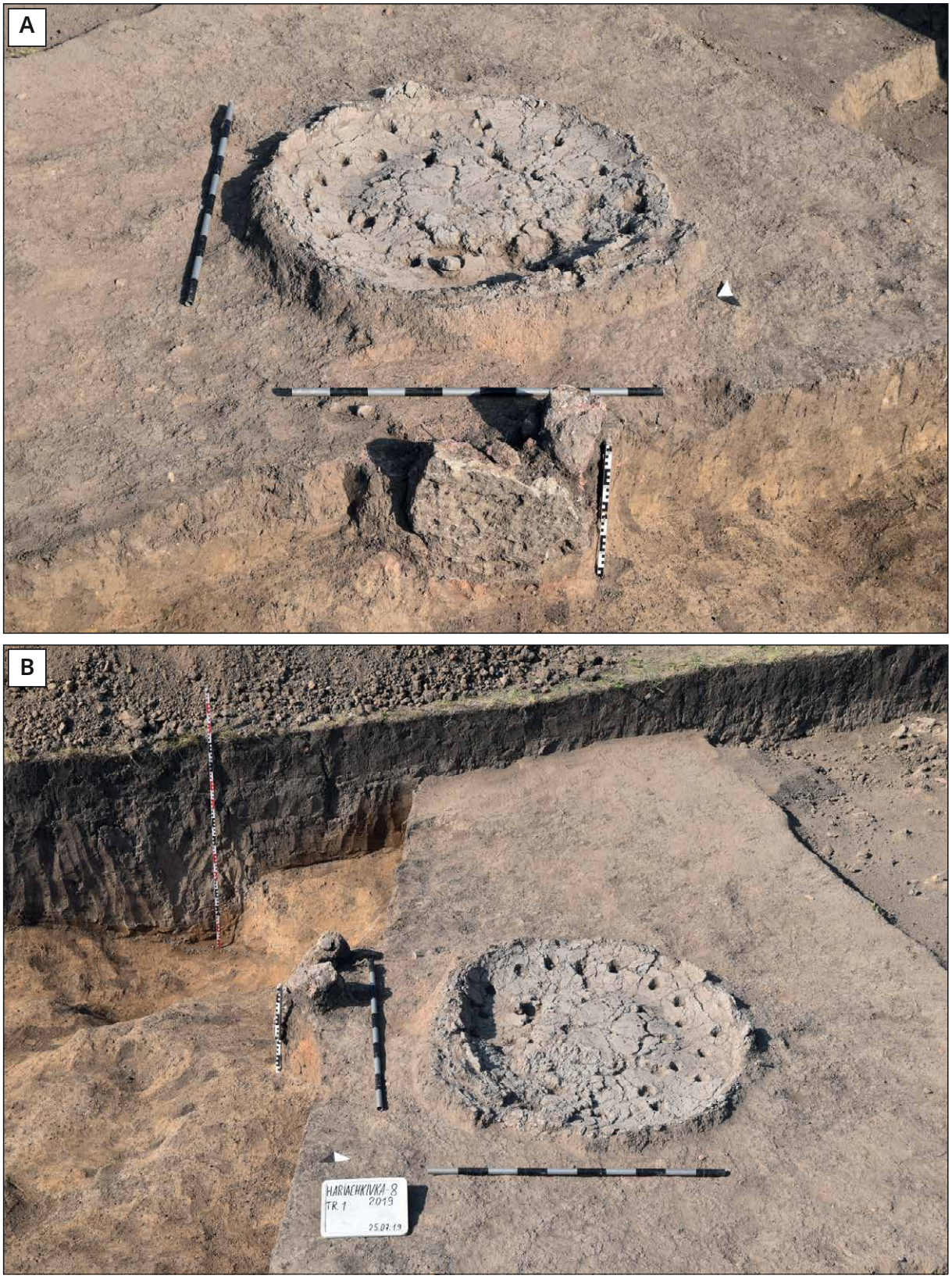
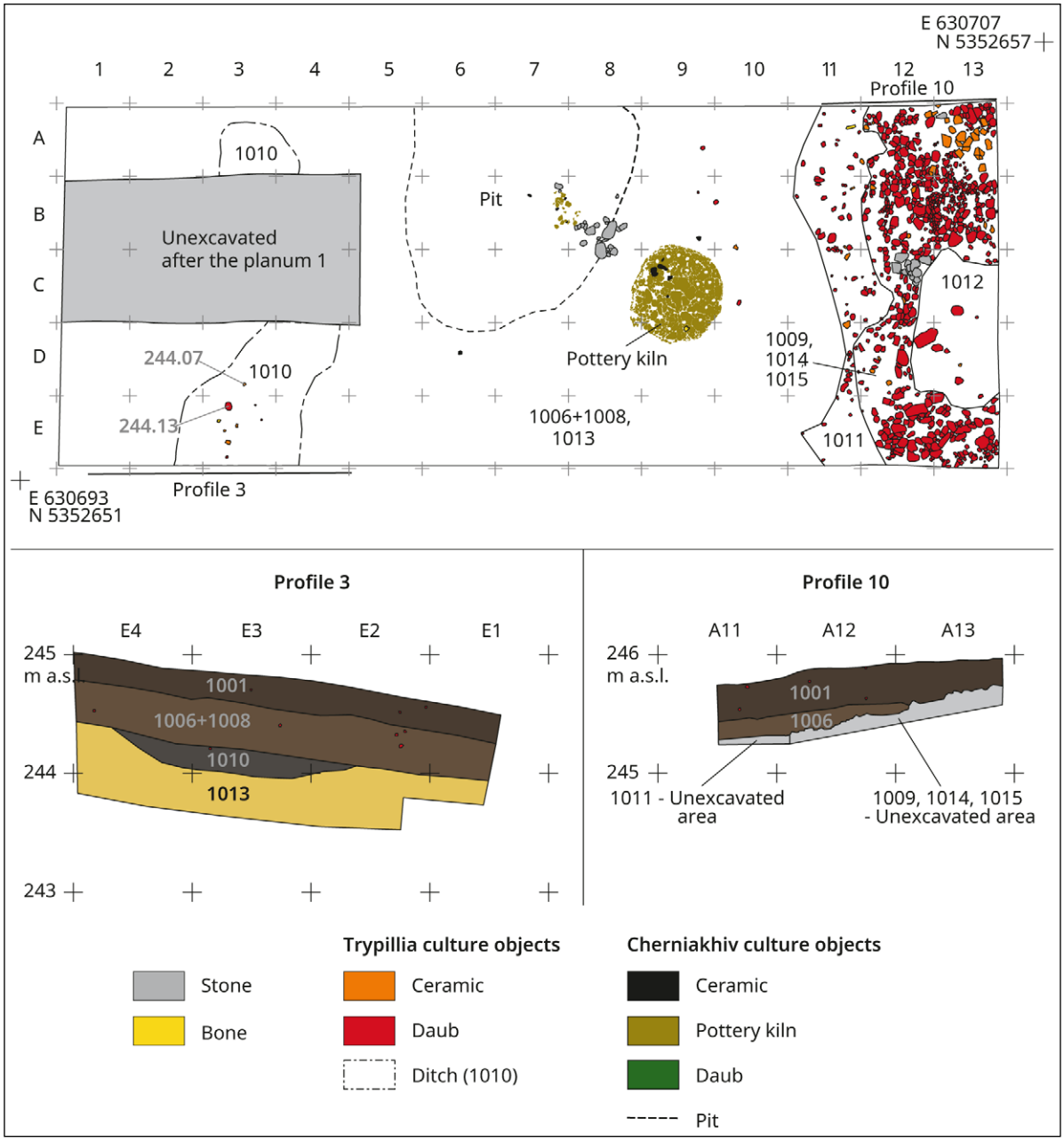


Figure 59. Hariachkivka 8, Trench 1: photos of the Roman age kiln (A, B) and the partly excavated pit (B) nearby; (A) view from the north-west; (B) view from the south-west.



of massive daub fragments, which are mostly preserved in the northern part of the building area examined. But in this area the surface of the fragments is also damaged by agricultural activity. The central part of the examined area is completely destroyed (1012). In the northern part, the position of the lower layer fragments has been substantially moved. The surface of the lower layer daub fragments is flat; on the underside there are prints of wooden constructions. The thickness of the fragments is 4–6 cm. The daub of Contexts 1009 and 1015 has admixtures of chaff. In the northern part of the examined area of the building, in Context 1009, there was a collapsed pear-shaped pot with deepened ornament. In the central part there was a fragmented mealing stone. Stand-alone findings of ceramics and animal bones came both from Contexts 1009 and 1014 (the soil layer, which is covered by the Context 1015).

A less compact, one-layered cluster of fragments of burnt daub, as well as several ceramic fragments and bones were found to the east of the building. This context

Figure 60. Hariachkivka 8, Trench 1: planum displaying the location of features excavated in the trench and the location of the profiles; Profiles 3 and 10 display the stratigraphical position of the ditch (1010), the position of the structure (1009, 1014, 1015) and ancient step surface (1011); 1001 – Chernozem, black-grey; 1006+1008, 1011 – grey-black, yellowish; 1010 – grey-yellow; 1012, 1015 – grey-yellow, 1013 – dark yellow.



Figure 61. Hariachkivka 8, Trench 1: photo of Profile 3, which shows the stratigraphical position of the ditch (1010). View from the south.



Figure 62. Hariachkivka 8, Trench 1: photo of the partly excavated wood-clay building (1009, 1014, 1015) in the eastern part of the trench. View from the north-west.

has the number 1011. The artefacts here are located 245.32–245.51 m asl deep. Single fragments of daub and Trypillia ceramics were found all over the trench in Contexts 1006 and 1008.

Thus the central part of the western lateral part of the wood-clay building was examined. The daub in Context 1009 represents presumably the remains of the walls of the upper storey, while massive daub fragments from Context 1015 are the floor of the second storey. The findings from Context 1014 were located on the ground floor. No constructions which could indicate the presence of interior detail in this part of the building were discovered. The space in the central part of the magnetic anomaly of the building, which has negative numbers of magnetic flux density, was discovered during the excavation – Context 1012.

The fragments of daub in Feature 1011 are probably also parts of the building. They could have ended up outside the building during the destruction or as a result of other processes after its burning. We assume that the artefacts of Context 1011 mark the ancient surface level.

The ancient surface level near the building was found 40 cm below the modern surface. Assuming that the ditch deepening occurred from this level, the maximum depth of the feature in the Eneolithic Age was no more than 45 cm. Within the trench the direction of the ditch is not linear, nor are the width and depth consistent in different areas. Therefore, the metric and morphological characteristics of the ditch could be irregular all over the feature; this was partly confirmed by the results of the geomagnetic surveying.

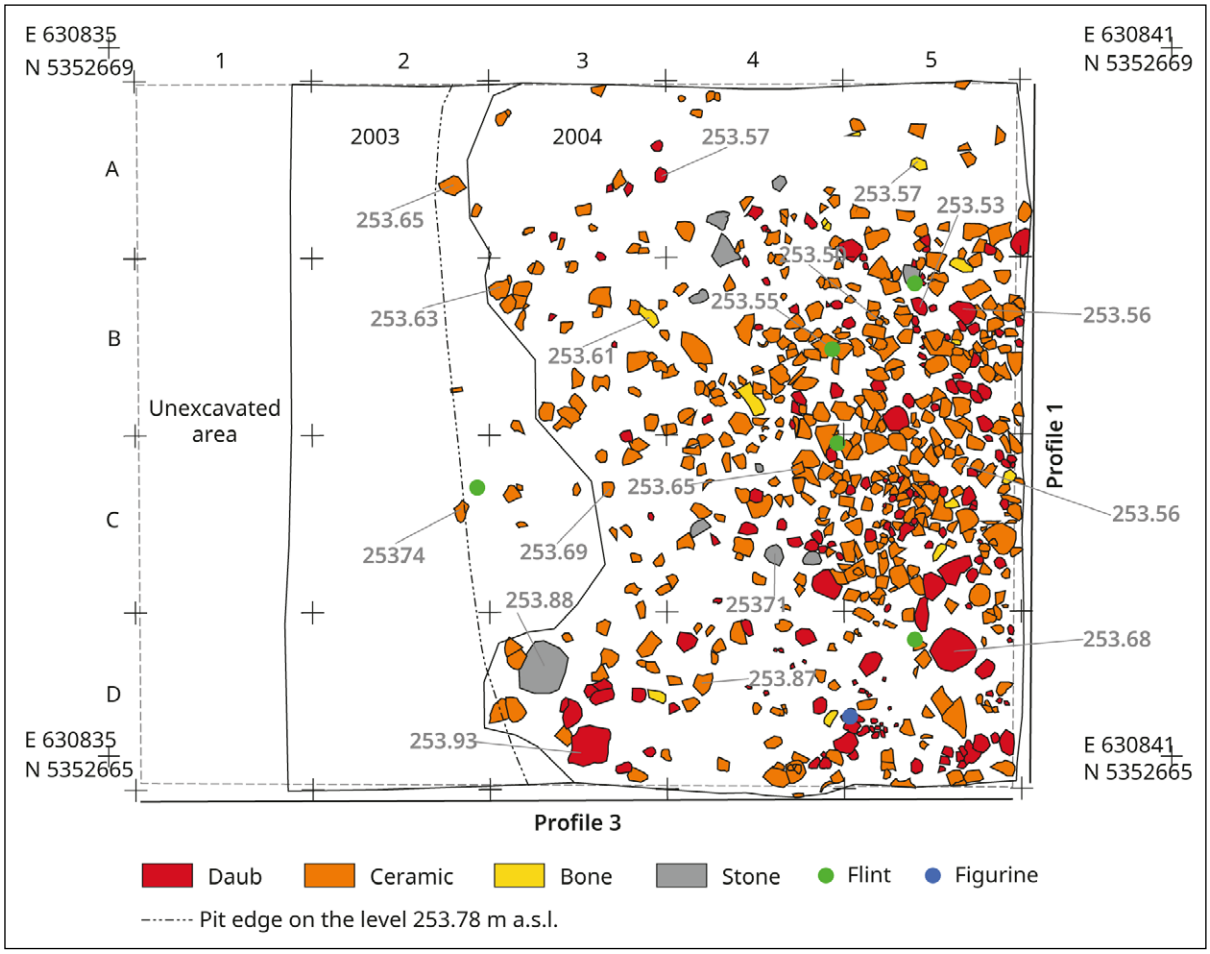


Figure 63. Hariachkivka 8, Trench 2: the pit filling (2004) at the level of Planum 1. Location of Profiles 1 and 3.



Figure 64. Hariachkivka 8, Trench 2: photo of Planum 1 displaying the pit filling (2004). View from the north-west.

Trench 2, pit

The purpose of the trench (5 × 4 m in size) was to investigate the magnetic oval anomaly of the pit measuring 9.5 × 7.7 m. The pit is probably the part of the complex with the building to the north of it (Fig. 57). This building is 20.5 x 8.5 m in size. It is located in the northern part of settlement's inner circle. The south-eastern corner of the trench is located approximately in the centre of the pit anomaly, meaning that the north-western quarter of the feature was investigated (Figs. 63, 64). This part of the pit is directed to the building.

The geological stratigraphy within the trench is represented by several layers with a clear sandy structure (Fig. 65). The lowest is the dark-yellow natural layer of clay (2005). Above it is the yellow-grey layer of loam (2003), up to 28 cm thick. The layer of humus, yellowish grey-black soil (2002) 27–32 cm thick overlaps 2003. Above it is the black-grey Chernozem (2001b) up to 25 cm thick, which is overlapped by approximately 22 cm of grey-black Chernozem (2001a).

Context 2002 also overlaps the main filling of the pit (Fig. 66). Above the pit it is up to 55 cm thick. Here, in the lowest part of the Layer 2002, an amount of pottery fragments (up to 10 cm), as well as clay crumb, daub fragments and single pieces of bones were found.

Below Context 2002 the cluster of artefacts was uncovered. It is located on the bottom of the pit (Context 2004), in the layer of yellowish grey-black soil. The artefacts in Context 2004 are spread across different depth levels. The highest are located in the south-western corner of the context, at the level of 253.88–253.93 m asl. The materials from the north-eastern and eastern parts of the context were found at the level of 253.53–253.68 m asl. Along the western edge of Context 2004, on the edge of the pit, some artefacts are located at the level of 253.63–253.74 m asl. The most compact cluster of artefacts is located in the eastern part of the context, in the deepest part of the pit. The lowest point of the bottom is at the level of 253.48 m asl.

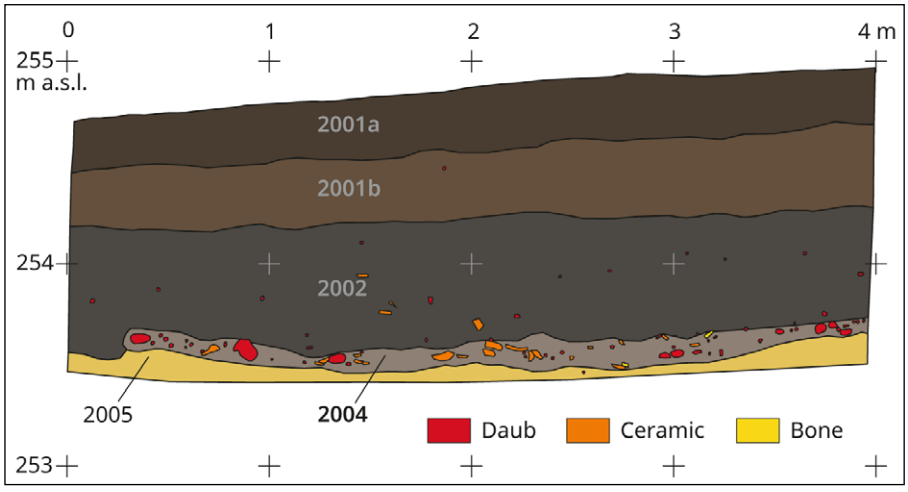


Figure 65. Hariachkivka 8, Trench 2, Profile 1: 2001a – grey-black, Chernozem; 2001b – black-grey, Chernozem; 2002, 2004 – grey-black, yellowish; 2005 – dark yellow.

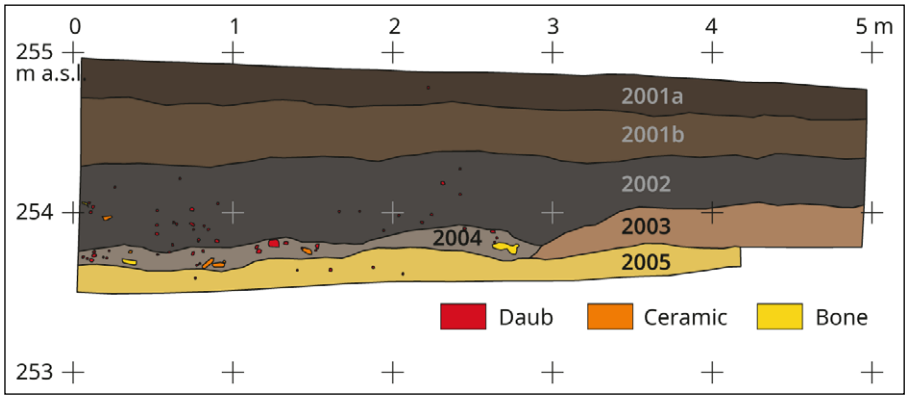


Figure 66. Hariachkivka 8, Trench 2, Profile 3: 2001a – grey-black, Chernozem; 2001b – black-grey, Chernozem; 2002, 2004 – grey-black, yellowish; 2003 – yellow-grey; 2005 – dark yellow.

In Layer 2004 several fragments of stones with polished surface, flint tools and flakes, as well as fragments of anthropomorphous and zoomorphous figurines and miniature vessels were found. A large amount of animal bones was found in the context, but most of the artefacts are fragments of ceramic vessels. Among the pottery, partial clusters (<50% of fragments) of small and medium size vessels were found.

There was almost 20 kg of daub in Context 2004, some of which was fragments of wooden-clay building elements. Most of them are 3–5.5 cm thick flat fragments, which are made of clay with small admixture of chaff. Some fragments have imprints of split wood and twigs on one side, about 3 cm in diameter. No systematic distribution of any category of the artefacts was found.

We assume that approximately at the level of 254.00 m asl is the level of the ancient surface, represented by the surface of Layer 2003. This assumption correlates with the evidence about the ancient surface level which was obtained in Trench 3 of the Hariachkivka 8 settlement. Judging by that, the initial depth of the pit in Trench 2 was no more than 50–55 cm in the deepest part. On the edge of the pit, its depth was around 30 cm. This means that the bottom of the pit is lens-shaped. The walls are sloping. The pit is dug mainly in the geological Layer 2003. Presumably the soil from layer (2005) was also extracted during pit's digging.

Cleary the filling of Context 2004 with the artefacts is linked to anthropogenic activity. They are possibly the waste accumulated during the existence of the nearby building. It is somewhat difficult to determine the nature of the lower part of Context 2002, however, we assume that the artefacts were here due to erosion processes, since the soil structure is homogeneous all over the context depth.

Trench 3, wood-clay building (mega-structure) and a neighbouring pit

Trench 3 with an area of 3 × 5 m has a latitudinal orientation and is located 19 m to the west of Trench 2 (Fig. 57). The goal was to investigate part of the pit anomaly (eastern part of the trench) and the south-eastern corner of the building anomaly (south-western part of the trench). The building is located in the north-western part of the inner circle. It is 29.6 × 9.8 m in size (290 m^2). The building is the largest in the settlement and we interpret it as the possible mega-structure. The long axis of the building in oriented in the direction north-west/south-east. Approximately 1.6 m to the east of the south-eastern corner of the building anomaly, the anomaly of the long pit is located. Its approximate size is 10.3 × 5.2 m, it stretches in a north-south line.

The compact cluster of daub fragments (3002), which are the remains of the building, were found in the south-western corner of the trench (Fig. 67). They are spread over an area of 1.00 x 2.15 m. The tops of the ruins were found at a depth of 60–70 cm below the modern surface, at 252.66–252.89 m asl. In some areas of the context two stratigraphical layers of building remains are clearly visible. The lower layer (3002a) is represented by 3.5–6.5 cm thick daub fragments (Fig. 68). The surface of the fragments is flat, carelessly smoothed. Two fragments in different parts of the cluster were turned over in order to find wood imprints. Both fragments have imprints of split wood, located in a north-west/south-east direction. The upper layer (3002b) is represented by amorphous daub fragments up to 4 cm in size. Some of these have imprints of split wood and twigs. The daub fragments from both layers are made of clay with a minimal admixture of chaff. The building remains were conserved.

To the north and mostly to the east of the building at the level of 252.65–252.77 m asl separate pottery and daub fragments were found, as well as several bone fragments. These artefacts are located in the yellow-grey soil layer (3004). It appears that these mark the level of ancient surface around the building. The density of their location is documented on Planum 1 (Fig. 67). In the same planum the upper part (Context 3005) of the pit filling is documented; the edge is located approximately 1.5 m to the east of the edge of the Building 3002.

The upper part of the pit filling (3005) is the yellowish black-grey soil. Below it is the Layer 3006 – grey-yellow soil, which has different thicknesses in different parts

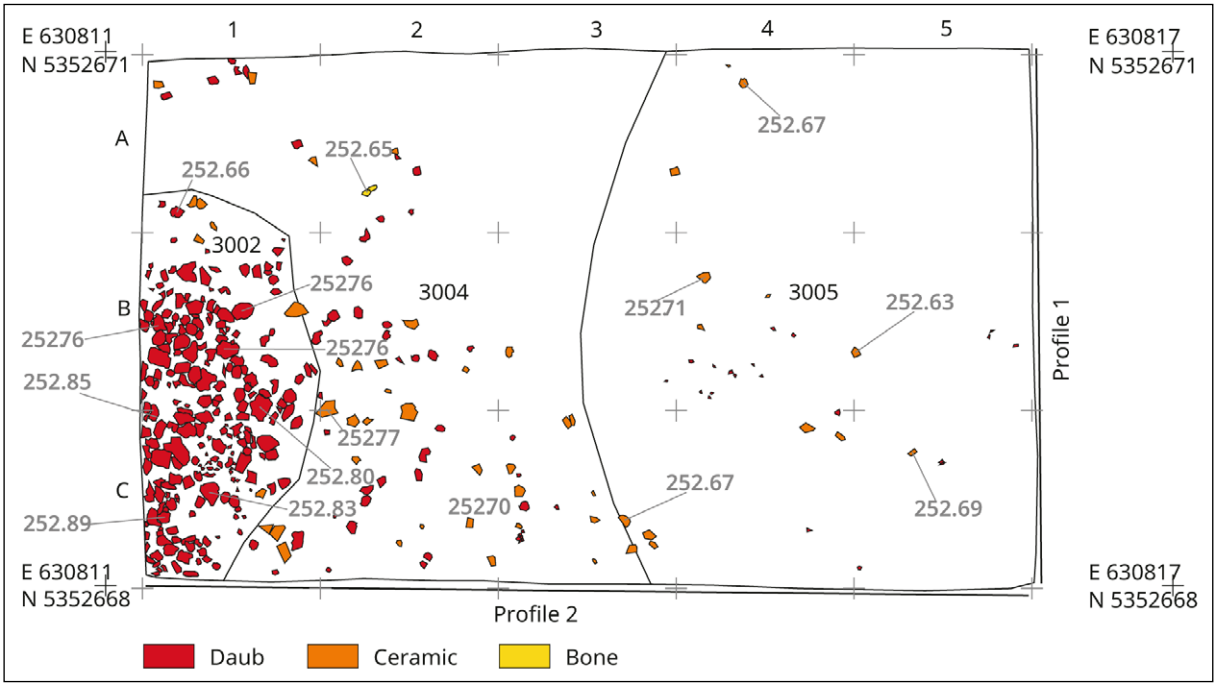


Figure 67. Hariachkivka 8, Trench 3: Planum 1 displaying the daub layer (3002) of the structure, the artefacts outside the structure (3004) and the upper part of the pit filling (3005). Location of Profiles 1 and 2.



Figure 68. Hariachkivka 8, Trench 3: photo of Planum 2 displaying the location of the daub layer (3002) of the structure (background of photo) and the pit filling (foreground of photo). View from the north-east.

of the pit. In the northern part of the investigated part of the pit, the layer (3006b) is 4–12 cm thick and contains small amount of daub fragments up to 2 cm in size, pottery and bone fragments. In this part it overlaps the layer of dark-yellow clay (3009) 10–19 cm thick, which contains a small number of artefacts among which fragments of pottery and bones up to 10 cm in size predominate. The daub fragments are almost absent. The soil of Context 3009 is partly at the bottom of the pit and partly overlaps the Layer 3007. The latter is very densely filled with artefacts – pottery and daub fragments up to 10–15 cm in size (Figs. 69–71). The daub is at the bottom of the pit, the pottery lies above. It includes the partial collapse of several vessels. The daub was burnt with less intensity and thus fragile, with the admixture of chaff. Among the pieces of daub, fragments that may belong to two interior constructions made of clay with an admixture of chaff were identified; the wall of an installation (trough) and the edge of a podium which was up to 8 cm high.

In the southern part of the pit, Layer 3007 is overlapped by Context 3006a, which differs from Context 3006b in having a larger amount of daub fragments and clay crumb. In the southern part of the pit the maximum thickness of the Layer 3006 is 53 cm. Mostly it lays on the bottom of the pit.

Stone and flint tools were found in the pit filling in Contexts 3003+3005, 3006 and 3007, a bone tool in Layer 3006 and anthropomorphous figurines in Context 3003+3005.

Within the pit (Grid B4) a copper product was found (Hoshko *et al.* 2020). During the excavation it was documented as artefact of Context 3003. The item was found 252.61 m asl deep, which indicates that it belongs to the lower part of the context, which is numbered 3003+3005 on Profiles 1 and 2 (Figs. 72, 73).

Considering that the deepest part of the pit is located at the level of 251.89 m asl, the original depth of the pit must have been approximately 85 cm. The bottom of the pit is not flat, presumably because of a number of small local deepened areas, as is seen on Profile 2 (Fig. 74). The walls of the pit are slightly sloping.

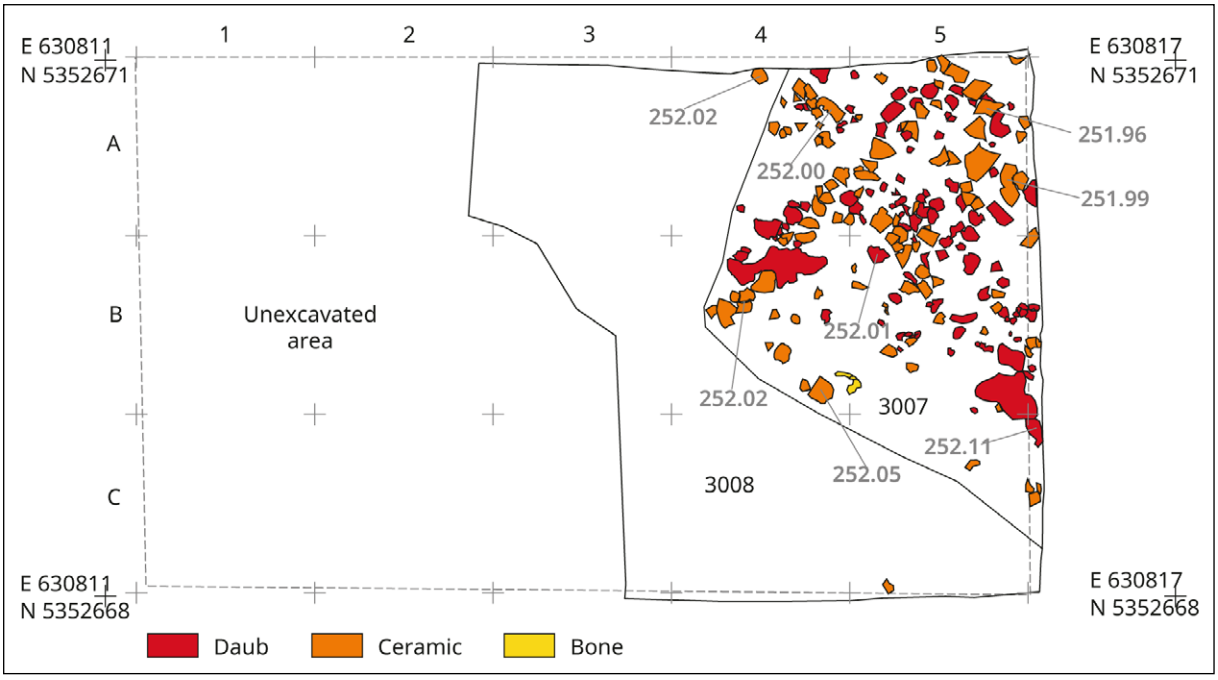


Figure 69. Hariachkivka 8, Trench 3: Planum 3 displaying the location of the artefacts (3007) on the pit bottom.



Figure 70. Hariachkivka 8, Trench 3: photo of Planum 3 displaying the location of the artefacts (3007) on the pit bottom.



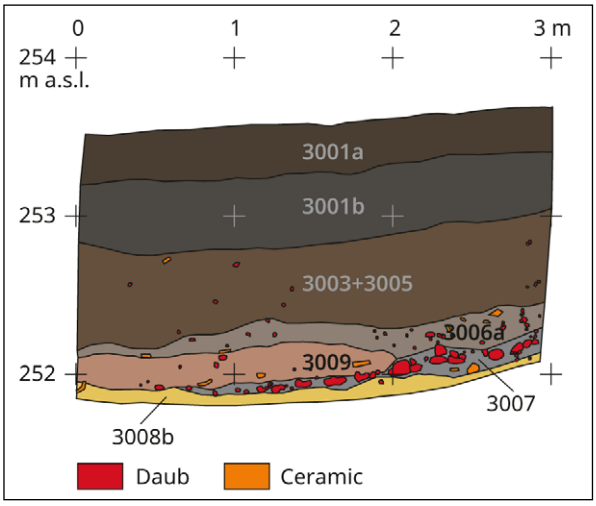


Figure 71 (above). Hariachkivka 8, Trench 3, Planum 3, Context 3007: photo of a collapsed bowl (Find-ID 3129) with incised ornamentation outside and painted ornament inside.

Figure 72. Hariachkivka 8, Trench 3: Profile 1 displaying the stratigraphy of the pit; 3001a – grey-black; 3001b – black-grey; 3003+3005 – black-grey, yellowish; 3006a, 3006b – grey-yellow; 3007 – dark yellow, brownish; 3008a, 3009 – dark yellow; 3008b – light-yellow or yellow-green.

The soil of the Layer 3003+3005 which is 18–22 cm thick overlaps the building ruins (3002) and the ancient surface layer (3004), above this, all over the trench, is a black-grey soil layer (3001b) 19–35 cm thick. The upper layer (3001a) is 21–30 cm of grey-black soil. Below Layer 3004 is a dark-yellow natural layer (3008a) 25 cm thick, below that is an inhomogeneous layer (3008b) which is light-yellow or yellow-green in different places. The soil of all the contexts is slightly sandy.

Using the results of the magnetic survey the corner of wooden-clay building was investigated. Possibly, it had two storeys, given the two layers of the daub. The upper layer (3002b) is the ruins of the walls of the upper floor, the lower layer (3002a) is the platform, the floor of the upper storey. The wooden elements of the structure, on which the platform was built, are located along the long axis of the building.



Figure 73 (above). Hariachkivka 8, Trench 3: photo of Profile 1. View from the west.

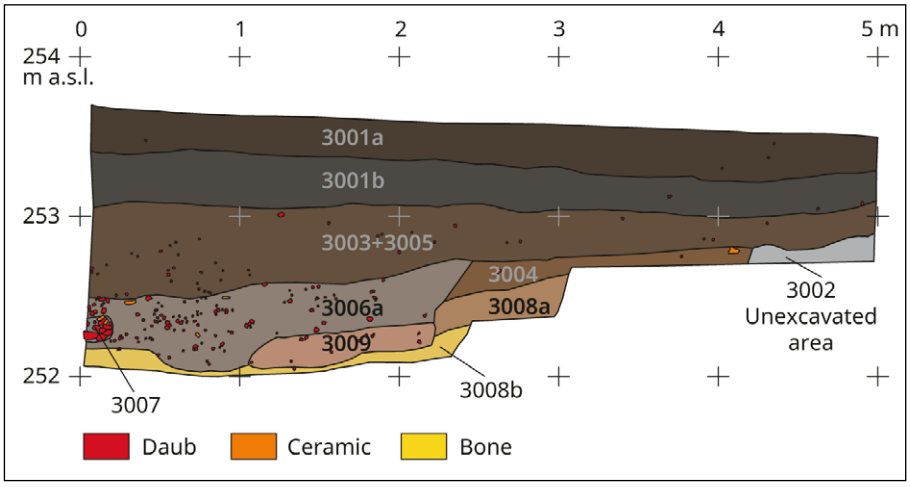


Figure 74. Hariachkivka 8, Trench 3: Profile 2 displaying the stratigraphy of the pit, the position of the structure (3002) and ancient step surface (3004); 3001a – grey-black; 3001b – black-grey; 3003+3005 – black-grey, yellowish; 3004 – yellow-grey; 3006a, 3006b – grey-yellow; 3007 – dark yellow, brownish; 3008a, 3009 – dark yellow; 3008b – light-yellow or yellow-green.

However, it is usual in the ordinary buildings of CT for the wooden elements of such constructions to be located across the axis. This unique case may be explained by the large size of the building. The width of the building is almost 10 m: and to build the platform on wood of such lengths without additional support at the level of the ground storey (pillars or walls) would be technologically unwise. It is possible that the location of the wooden elements under the platform was also due to the internal division of the ground storey of the building into separate rooms, the configuration of which dictated the direction of inter-floor wood elements.

In our opinion, the origin of the pits at the Trypillia settlements is primarily due to the necessity of acquiring the building materials for the wooden-clay buildings. After that the pit was filled for as long as the building functioned. These are two consecutive processes, which have been repeatedly documented during pit excavation at the settlements of the Dniester-Bug region. Using the pit from

Trench 3 of the Hariachkivka 8 settlement as an example, we documented that in the process of filling with waste, other activity also took place. Presumably this was linked to the extraction of the small amount of building material. This is indicated by the layer of natural clay 3009, which contains a small number of artefacts and also overlaps the Layer 3007 which is densely filled with domestic waste. At the bottom of Context 3007 there are daub fragments, burnt with less intensity, that represent interior details and perhaps other elements of the building's construction.

The natural origin of the Context 3003+3005 unquestionable, given the homogeneous character of the soil all over the trench and its stratigraphic position, lying immediately above the building ruins. Therefore, some of the artefacts located in this context could have entered the pit as the result of erosive processes, and others as the result of human activity.

Trench 4, Late Roman Age pottery kiln

As a result of magnetic scanning, the anomaly of the presumed pottery kiln was identified in the northern part of the settlement (Fig. 57). The form of the anomaly resembles a circle, its size is 3.1 × 3.0 m. It is located between the anomalies of the outer circular row. The western edge of the anomaly touches the rectangular building anomaly. The distance between the building to the east of the kiln is only 1.3 m. The simultaneous functioning of all three objects could have caused the fire.

The test trench measuring 2 × 2 m was located above the north-eastern quarter of the feature (Fig. 75). During the excavation the walls of the pottery kiln upper chamber were found, which are identical to the kiln examined in Trench 1. In addition, the inner space of the chamber is filled with artefacts, predominantly ceramic fragments of the Cherniakhiv culture, which directly indicates the chronology of the feature. Further excavations were not conducted; the feature was conserved.



Figure 75. Hariachkivka 8, Trench 4: photo of Planum 1, displaying the position of the firing chamber wall of the Late Roman Age pottery kiln and artefacts inside the chamber. View from the north.

Trench 5, wood-clay structure

One of three anomalies of the presumed kilns was examined by a test trench of 3 × 3 m (Fig. 57). It is the largest anomaly, 4.5 × 3.6 m in size, is oval in shape, elongated in a latitudinal direction. The anomaly is located in the eastern part of the settlement, and is a part of the less densely built outer circle. Close to the feature, 2.3 m to the south, the building anomaly is located. Its long axis is also oriented in a latitudinal direction.

In the central and south-western parts of the trench, over an area of 1.9 × 2.5 m, a compact cluster of building ruins was found (Context 5002; Figs. 76, 77). The position of the building ruins was traced, clearly lying in two sequentially arranged stratigraphical layers. The upper layer (5002a) contains amorphous, chaotically arranged daub fragments; the lower one (5002b) contains fragments with smoothed surfaces, about 3–4 cm thick. The daub from Contexts 5002a and 5002b is made of clay with an admixture of chaff. A less compact cluster of building ruins is also located in the north-western corner of the trench. The rest of the test trench area (Context 5003), the space along the northern and eastern walls of the trench, contains stand-alone daub and pottery fragments, as well as few bones. The artefacts are located in yellowish black-grey soil. This layer of soil partly covers the building ruins, except for the south-western edge of the test trench. Here the upper part of the ruins (Context 5002a) is directly covered by a 43–45 cm thick Chernozem layer (5001). In this part of the test trench the upper layer of the building ruins was destroyed by agricultural activity. Several fragments of daub from upper layer of the building had wood imprints.

The tops of daub fragments (5002) were located at the level of 258.90–259.08 m asl; the artefacts in Context 5003 were located at the level of 258.87–258.96 m asl. Deconstruction of the building ruins and excavations of Context 5003 below the level of Planum 1 were not conducted.

Among the building ruins a partly preserved clay installation was found (5004). It has one layer, 3–4 cm thick. It is formed of the sandy clay. It is built on the platform (5002b). In the south-western part of the trench (Grids C1 and C2) the feature is damaged by modern agricultural activity. The northern part of the feature is partially covered by daub from the Context 5002a. Overall the fragments of the installation are spread over an area of 101 × 64 cm. The surface of the feature is flat. In the central part of the construction, where its fragments are arranged in a mostly compact way, three round deepenings in the surface were found. They form an almost equilateral triangle. The distance between their centers is 30–32 cm. The diameter of the best-preserved feature (the northern one) is 12 cm. The others were presumably of a similar size.

Near the installation (in Grid C2) fragments of a semi-spherical vessel with thick walls were found. It was made of clay with the admixture of chaff. In addition, a fragment of a grinding stone and some collapsed fineware pots with paint decoration were located on the platform.

Part of the wooden-clay building was investigated in the trench. The location of the building ruins in two layers may initially indicate that the building had two storeys. The upper layer is mainly the ruins of the walls, the lower layer is the platform – covering of the ground floor. The clay installation is located on the platform, on the upper floor. The vessels and the grinding stone indicate domestic processes, organised near the installation.

The unique nature of the interior detail is intensified by the presence of three semi-spherical hollows in its surface (Fig. 78). Similar deepening was also found in the centre of the clayish platform of Building 5 at the Shkarivka settlement, Trypillia B1–B2 stage (Tsvek 2006, 54). Another unusual find is the semi-spherical bowl made of clay with admixture of chaff, atypical for ceramics. Such dough is usually typical for storage vessels (Shumova 1988). Similar artefacts, referred to as ‘cups’, were found at the Ozheve-Ostriv settlement, Trypillia B1 stage (Chernovol 2014) as well as a fragment in Building 7 of the Bilyi Kamin settlement (Rud *et al.* 2019a). The cups on the Ozheve-Ostriv settlement were located at the edges of the buildings, opposite

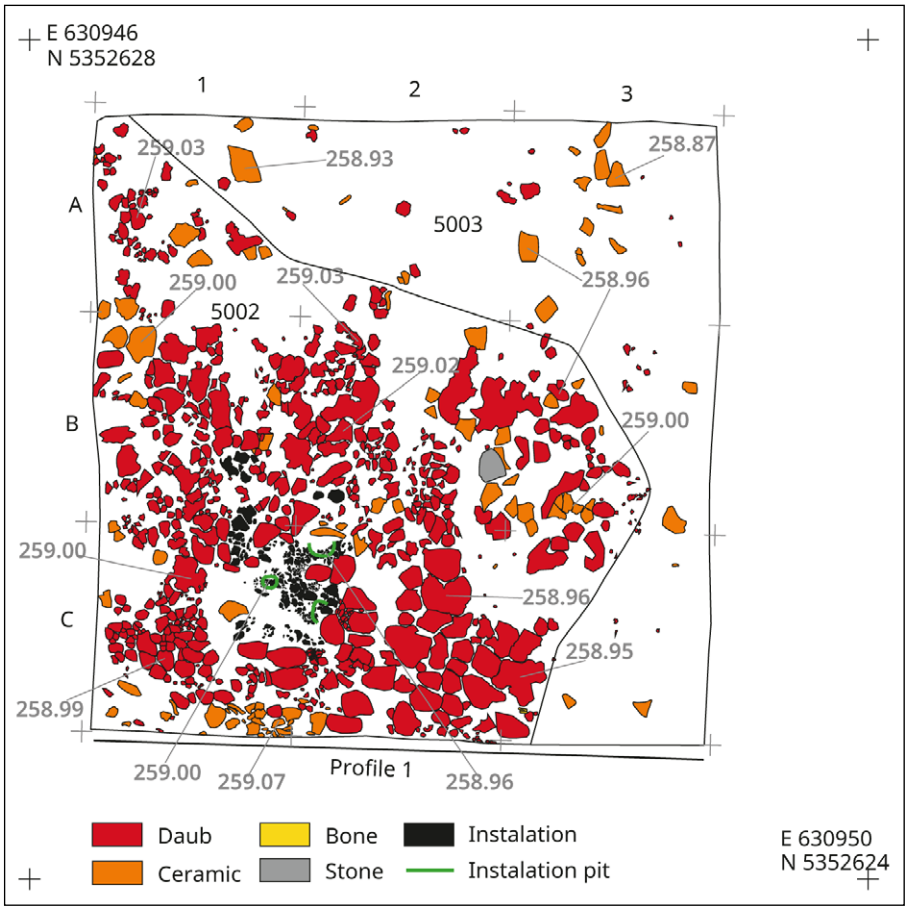


Figure 76. Hariachkivka 8, Trench 5: Planum 1 displaying the compact daub layer (5002) of the structure and the artefacts' positions (5003) outside the compact daub layer. Location of Profile 1.

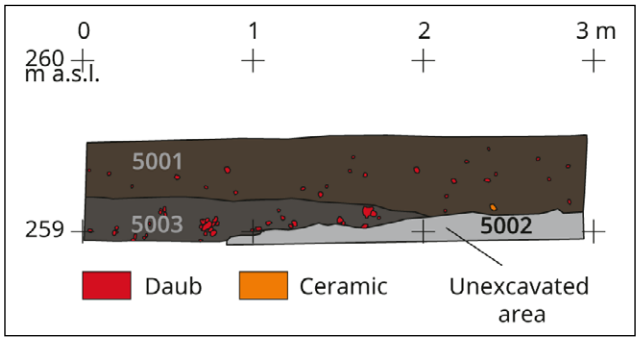


Figure 77. Hariachkivka 8, Trench 5: Profile 1 displaying the stratigraphy of the southern trench wall; 5001 – Chernozem; 5002 – building ruins; 5003 – black-grey, yellowish.

to the entrance, where the central clay installation is usually located, the so-called 'altar'. This allowed the assumption that the cups played a role of the 'altar' and served as places for sacrificial offerings (Chernovol 2019, 102). At the Bilyi Kamin settlement, cup fragments were found near the trough in which the grinding stone was placed, which, in our opinion, may indicate a domestic purpose for the cup, linked to grain processing. But the ritual purpose is also possible.

There is no evidence to clearly interpret the origin of the artefacts in Context 5003. They may indicate the level of the ancient surface outside the building. Or, considering the less compact cluster of the daub in the north-western edge of the trench and the presence of stand-alone fragments all over the context, these artefacts may mark the building ruins.



Figure 78. Hariachkivka 8, Trench 5, Planum 1: photos of the clay installation (5004) with three holes in it.

^{14}C dating

From bones recovered during our excavations at the Hariachkivka 8 settlement, 13 ^{14}C dates were obtained (Suppl. 1 in Chapter 19, this work, Vol. II).

From Trench 1 there were four dates, two of which were recovered from the backfill of the ditch (Poz-128146 and Poz-128147) and two from the burnt house in the east of the investigated area (Poz-128390 and Poz-128266). According to a Bayesian model, the ditch was filled with the highest probability between 4225 and 4040 BCE (Tab. 10; Fig. 79).

The two dates from the burnt house area are very inconsistent. The dating range using a Bayesian model is correspondingly long, according to which the house dates most probably to the period between 4450 and 4050 BCE (Tab. 11; Fig. 80).

The three largely consistent dates Poz-128148, Poz-128149 and Poz-128135 were taken from the lower part (Feature-ID 2004) of the pit examined in Trench 2. According to a Bayesian model, the dated backfilling layer was deposited with the highest probability between 4230 and 4050 BCE (Tab. 12; Fig. 81).

	Dating range 68.3%	Dating range 95.4%	Median	Highest dating probability
Boundary start ditch fill	4369–4071	4936–4053	4250	4225 or 4155
Duration	0–465	0–1340	243	115 or 185
Boundary end ditch fill	4213–3901	4227–3239	4017	4040

Table 10. Hariachkivka 8: Bayesian model of the backfilling process of the ditch investigated in Trench 1. A_{model}=104.4, $A_{overall}$=104.1. All boundary dates in BCE, duration in years.

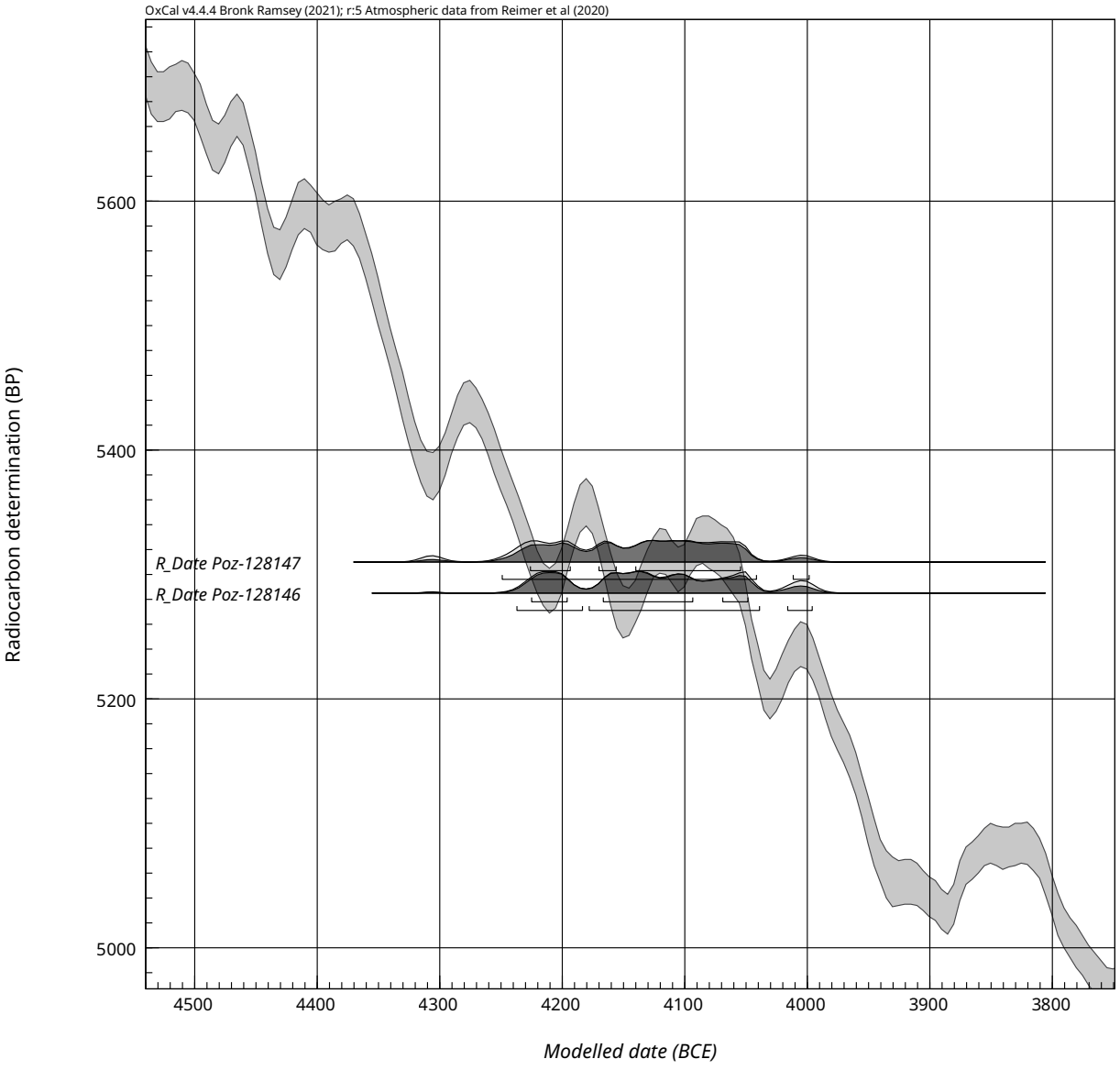


Figure 79. Hariachkivka 8: curve plot of two modelled ^{14}C dates from the ditch filling in Trench 1.

The two dates Poz-128141 and Poz-128142 were obtained from bones of medium sized mammals taken from different parts of the house investigated in Trench 5. Sample Poz-128141 was recovered from the area to the east of the burnt clay package of the building (Feature-ID 5003). Sample Poz-128142 was recovered from the upper layer of the burnt clay package of the building (Feature-ID 5002).

A Bayesian model assumes that both samples represent the period of use of the building. With the highest probability, the deposition of the bones took place between 4330 and 4250 BCE (Tab. 14; Fig. 83).

Table 11. Hariachkivka 8: Bayesian model of the backfilling process of the burnt house investigated in Trench 1. A_{model}=99.4, $A_{overall}$=99.4. All boundary dates in BCE, duration in years.

	Dating range 68.3%	Dating range 95.4%	Median	Highest dating probability
Boundary start house	5493–4366	5499–4360	4617	4450
Duration	199–1212	134–2107	724	400
Boundary end house	4229–3159	4236–3154	3954	4050

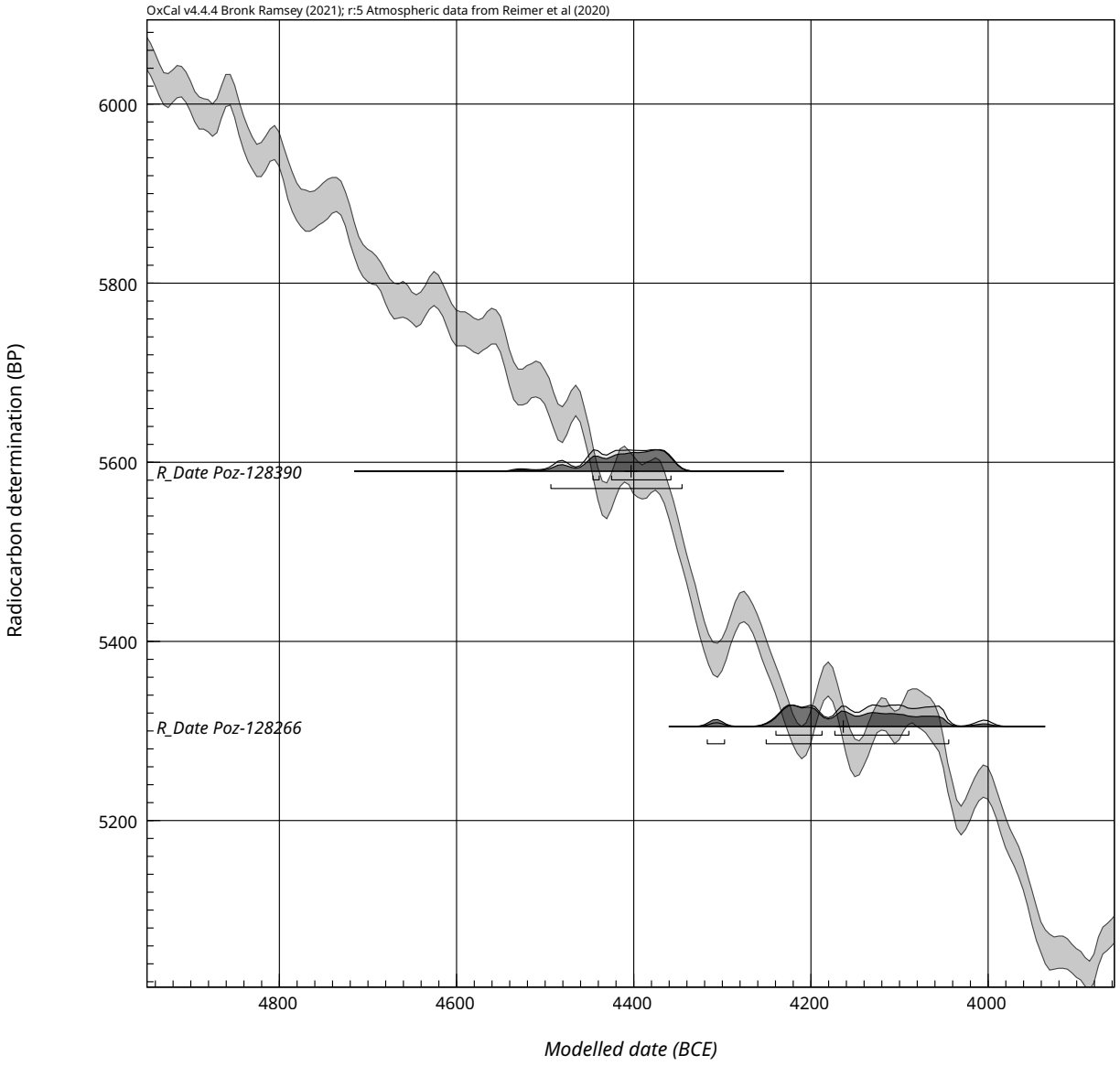


Figure 80. Hariachkivka 8: curve plot of two modelled ^{14}C dates from the burnt house in Trench 1.

Vilshanka

Research history

The information about the Vilshanka settlement in the Turska Stinka (common local name) was documented for the first time by I. Ch. Zborovskyi in 1929. The report about finds of pottery fragments came from local people (Zborovskyi 1929, 17).

	Dating range 68.3%	Dating range 95.4%	Median	Highest dating probability
Boundary start pit backfill	4273–4102	4584–4048	4211	4230
Duration	0.216	0–849	126	180
Boundary end pit backfill	4201–3983	4233–3683	4061	4050

Table 12. Hariachkivka 8: Bayesian model of the backfilling process of the pit investigated in Trench 2. A_{model}=111.1; $A_{overall}$=110.2. All boundary dates in BCE, duration in years.

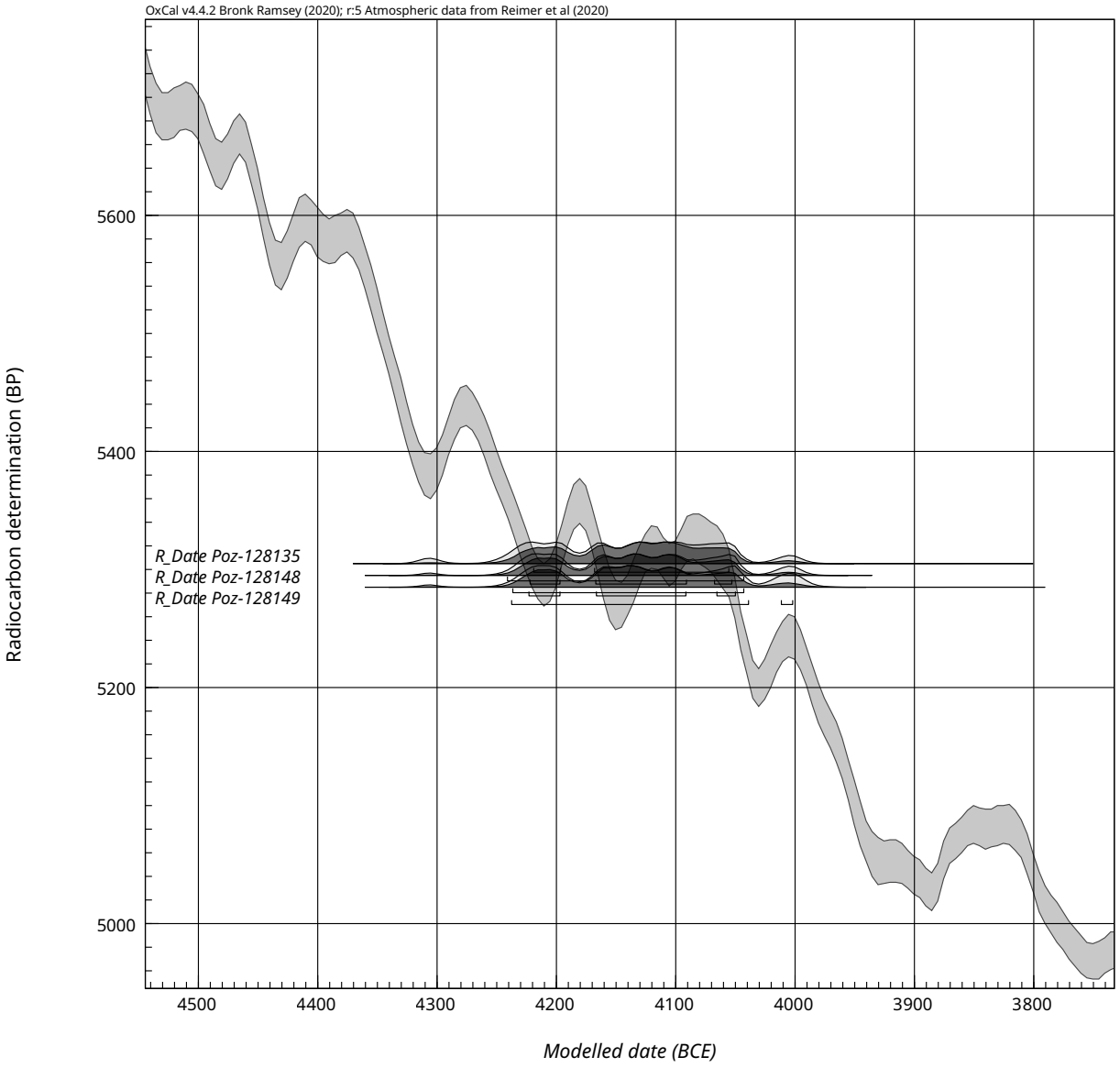


Figure 81. Hariachkivka 8: curve plot of three modelled ^{14}C dates from the pit in Trench 2.

In the 1980s the local historian B. H. Vitsa (1992, 8), along with students from the local school, investigated the site several times and made a representative surface collection of the artefacts, which was kept at the school museum of Zelenianka village (Kryzhopil territorial community, Tulchyn Raion), and was lost during the school's reorganisation. In this collection was the fragment of a house model (probably open type) painted black, published by S. O. Husiev (1995, 22, Fig. 6: 1) after he examined the collection in 1990. The analysis of the collection was done in cooperation with

Table 13. Hariachkivka 8: Bayesian model of the backfilling process of the pit investigated in Trench 3. A_{model}=87.5, $A_{overall}$=89.8. All boundary dates in BCE, duration in years.

	Dating range 68.3%	Dating range 95.4%)	Median	Highest dating probability
Boundary start house use	4498–4257	5156–4245	4377	4330
Duration	0–457	0–1394	237	80
Boundary end house use	4325–4037	4335–3324	4167	4250

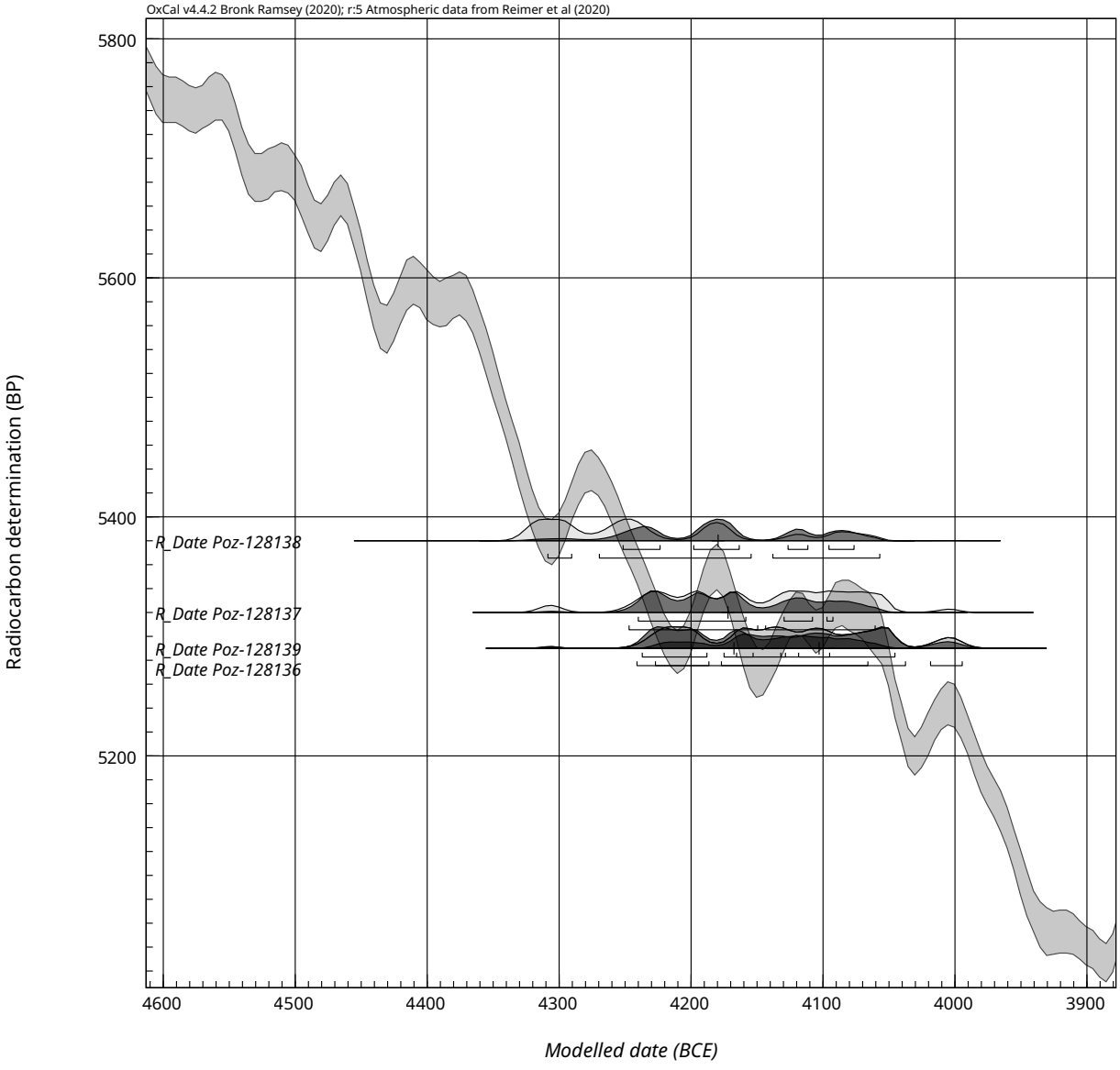


Figure 82. Hariachkivka 8: curve plot of four modelled ^{14}C dates from the pit in Trench 3.

V. A. Kosakivsky. At that same time the settlement territory was surveyed by the researchers. The small amount of surface artefacts collected (fragments of vessels and flint tools) from this fieldwalking is kept in Vinnytsia Regional Museum of Local History and the archaeological laboratory of Vinnytsia State Pedagogical University.

In spring 2017, the cooperation between CAU and IA NASU led to a magnetic survey of the settlement. The deepened features with Trypillia culture artefacts were documented in the walls of the illegal stone quarry, which was organised on

	Dating range 68.3%	Dating range 95.4%	Median	Highest dating probability
Boundary start lower backfill	4270–4089	4362–4060	4208	4235
Duration	0–87	0–252	47	70
Boundary lower-upper backfill	4191–4059		4137	4165
Duration	0–94		47	115
Boundary end upper backfill	4166–3993		4067	4050

Table 14. Hariachkivka 8: Bayesian model of the use of the house investigated in Trench 5. A_{model}=106.9, $A_{overall}$=107. All boundary dates in BCE, durations in years.

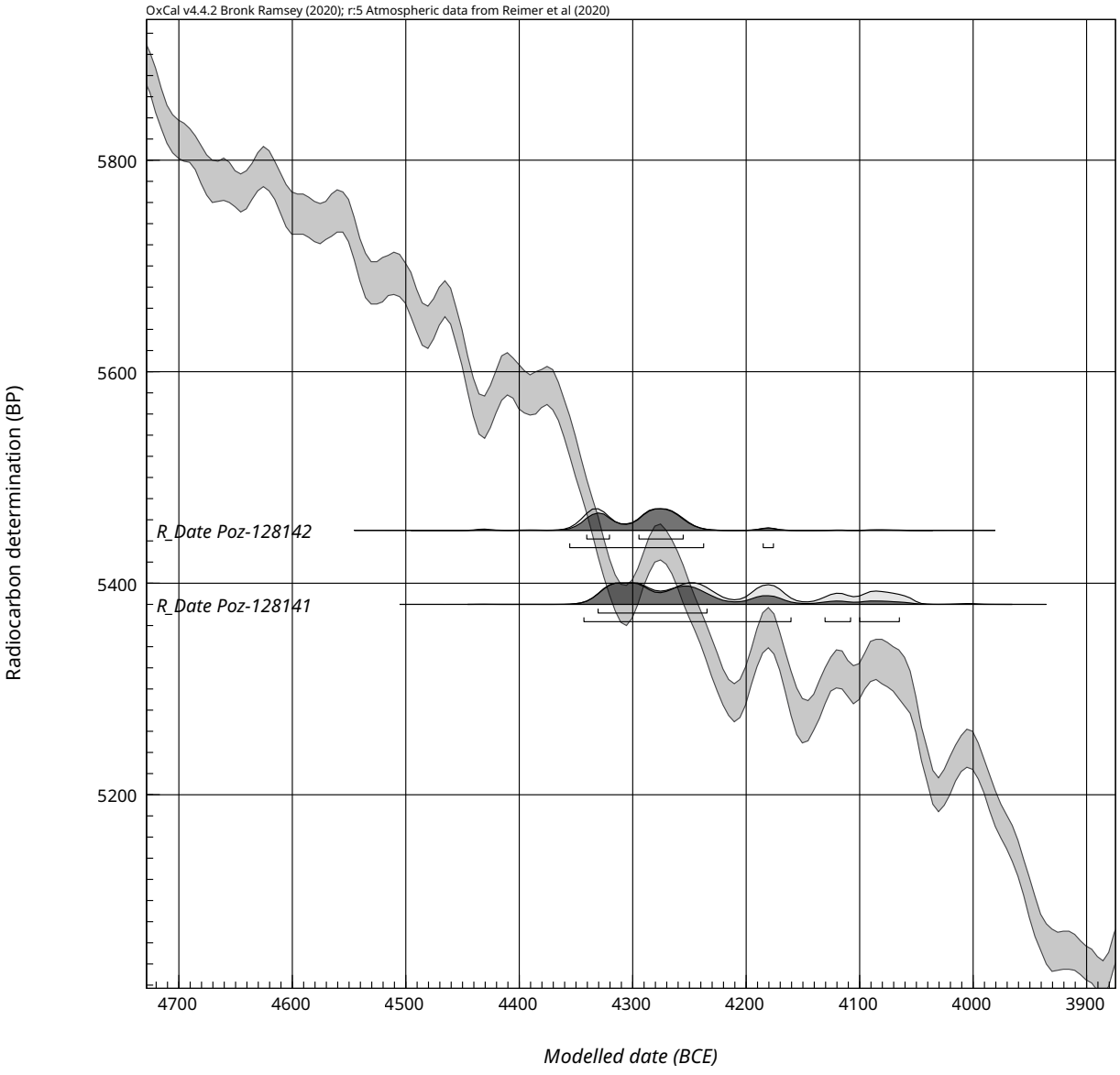


Figure 83. Hariachkivka 8: curve plot of two modelled ^{14}C dates from the house in Trench 5.

the outskirts of the settlement. Flint tools of the Szeletian cultural tradition from the beginning of the Upper Palaeolithic (~35–27 kya)[4] were found in the central part of the Eneolithic settlement.

4 This conclusion was reached by Leonid Zalizniak, Doctor of Historical Sciences, Head of the Department of Prehistoric Archaeology of the Institute of Archaeology of the National Academy of Sciences of Ukraine.

Geographical position

The Vilshanka settlement (48°12'44.52"N, 28°35'51.66"E) is located 0.7 km south of the Vilshanka village (Horodkivka territorial community of the Tulchyn Raion). It is located on the flat promontory of the Vilshanka (Vilshanka → Markivka → Dniester) River's left coast, 16 km to the north-east of the Dniester River (Figs. 84, 85). From the north-west and from the west the territory is enclosed by the steep slopes leading down to the valley of the Vilshanka River. From the east it is guarded by the plateau slopes, which is higher than the promontory. From the south the promontory's terrain is bounded by a deep valley, at the bottom of which a small stream runs (the left overflow of the Vilshanka River), while from the north-east it is bounded by the gully, which also ends in the river valley. The level of the promontory is higher than the river valley by 50–60 m.

The whole area of the settlement is free of modern buildings, roads or trees. 1.7 ha of the south-west edge of the promontory is destroyed by the stone quarry. There is an identical quarry is on the edge of the north-east gully. Should it be expanded, the cultural layers of the site will also be damaged.

The surface of the promontory is constantly affected by natural erosion processes. The highest layer of the soil in the topographically highest parts of the settlement (in the centre and in the east) is Chernozem with a large amount of sand. From a topographical perspective, the lowest parts of the promontory, especially at its edges (north, west and south-west parts) are more eroded, therefore the highest layer of Chernozem with sand contains a large amount of small stones. It comes from slightly cemented layers of sandstone, which lies lower than the Chernozem. The thickness of Chernozem on the promontory edges is 25–40 cm. During the superficial investigation, a large number of artefacts (pottery fragments, flint tools, daub) were found, which confirm the high level of the cultural layer's destruction, both from the natural reasons and as a result of agricultural cultivation.

Magnetic survey

The geomagnetic survey was performed on an area of 20.9 ha of the Vilshanka settlement (Fig. 86). Anomalies of archaeological features were found over an area of 18.9 ha. The scanning was conducted on most of the territory of the settlement, excluding two sectors in the north and north-west parts of the site which have a total area of 4.5 ha. Including also the part of the promontory which was destroyed by the quarry, the total area of the settlement would be about 25 ha.

The magnetic anomalies within the Vilshanka settlement are mostly unclear, and so are hard to interpret. This is due to geological specifics, unlike (as an example) those from the settlements in the Southern Bug basin. The geomagnetic anomalies of the settlement can be divided into following categories (Fig. 87):

- 62 rectangular anomalies, which are the ruins of burnt clay buildings.
- 15 rectangular anomalies, which are contours of buildings of different construction or eroded.
- 31 anomalies of rectangular or oval forms, most likely to be eroded buildings.
- rectangular anomaly of the unique building, the so-called 'mega-structure'.
- circular anomalies of kilns or pits, filled with daub.
- anomalies of presumed pits.
- quadrangular anomaly of a feature atypical for the Trypillia culture.
- linear anomaly, presumably a ditch.

The geomagnetic survey showed that the promontory where the settlement is located is separated from the plateau by the linear anomaly which is presumed to be the ditch. The length of the part that was discovered is 800 m. The width of the





Figure 84 (above). Vilshanka, view of the site from the south. Photo taken during the magnetic survey of the site in March 2017.

Figure 85. Vilshanka, view of the promontory on which the settlement is situated and of the valley of the Vilshanka River. View from the north-west. Photo taken during the magnetic survey of the site in March 2017.

ditch varies in different places. In the central and south parts of the ditch where the magnetic flux density value is less than 2 nT, the width is 1.5–2.6 m. The north part of the ditch has 4–6 nT value and 2.9–3.7 m wide. We assume that such differences are the result of erosive processes, since the north side of the ditch is located on the long steep part of the promontory, which led to the natural erosion of the ditch.

The settlement's plan is based on the two circular rows of buildings of the three above-listed categories of structures. The inner circle is 190 × 150 m, the outer is 330 × 270 m. The building density is not evenly distributed in both of the rows. Because of this, the distance between the circles (ring-corridor) in different places is 30–80 m.

The distance between the buildings of the inner circle is mostly 3–18 m. There are also gaps that are free of buildings and 35–50 m long. The buildings of the outer circle are located less densely. The distance between them is 50–100 m. Some of them are close to each other, 2–6 m apart.

Outside the outer circle, to the south-west, there is a group of buildings oriented in a radial direction. Outside the outer circle, to the east the buildings are set in radial rows. It appears that there were at least 6–7 rows. Most of the buildings here are set in a north-south direction; a small number are oriented in an almost east-west direction. The most distant eastern buildings of the radial rows are a maximum of 180–200 m away from the outer circle. The maximum number of buildings in the row is 12. The buildings of the eastern part of the outer circle are located at the edge



Figure 86. Vilshanka: magnetic plan of the site against the background of the Google satellite image. The location of Profiles 1 and 2 on the edge of the stone quarry.

of the buildings' radial lines. This means that the distance between them correlates with the width of the corridors between the radial lines, which is 30–43 m.

The central part of the settlement (the area inside the inner circle) is mostly free of buildings. There are only seven anomalies of buildings, the long axis of which is close to the direction of the nearby buildings of the inner circle. Some of the buildings are set in groups of 2–6, both in circles and in radial rows.

The anomalies of the eroded buildings are located all over the settlement, with a slightly higher amount in the western part. The other two categories dominate in other areas. The anomalies of burnt wood-clay buildings are present in the central and eastern parts of the settlement, while anomalies of the buildings with clear rectangular contours are located mostly in the western part of the settlement. We assume that this spatial distribution is due to the erosion processes on the promontory. That is to say that the buildings that are represented by the anomalies

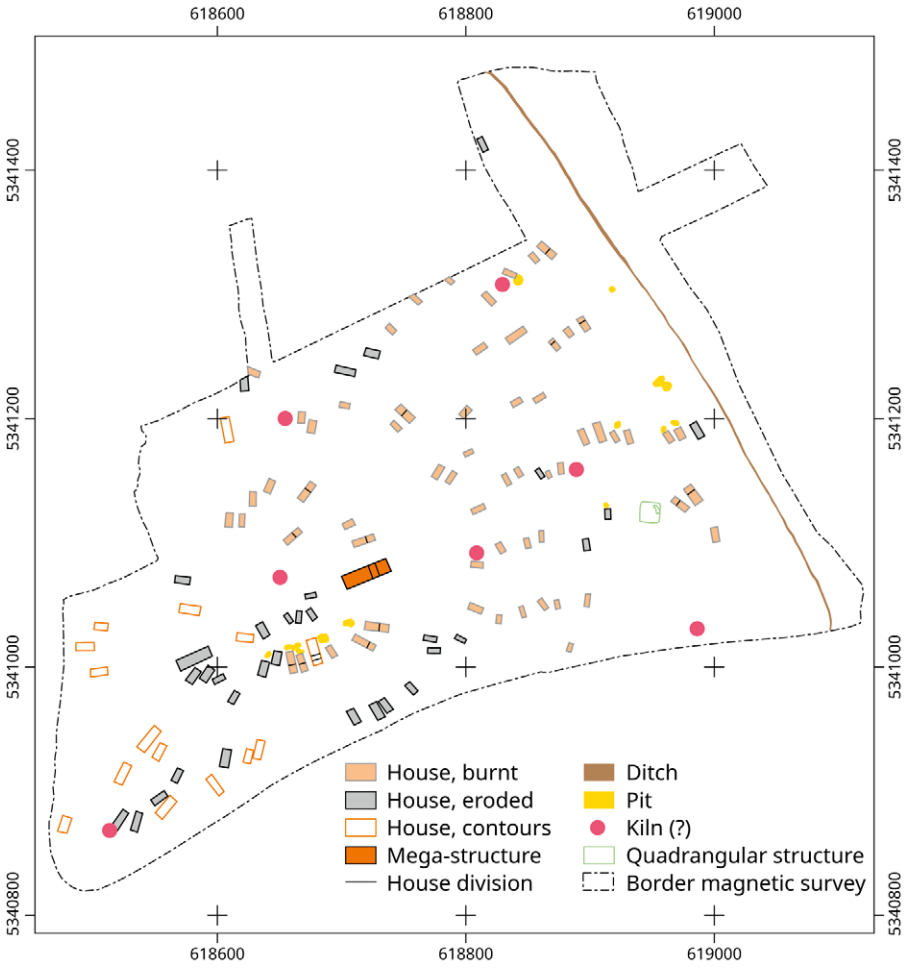


Figure 87. Vilshanka: interpretation of the magnetic features.

of the rectangular contours could be the traces of almost destroyed wood-clay buildings. Considering the fact that the sandstone layers are not very deep, these anomalies could be the remains of the buildings of atypical construction.

The 'mega-structure' with an area of 390 m^2 (approximately 37.5 x 10.5 m) is located in the eastern part of the inner circle (Fig. 88). Its long axis has the azimuth direction of 75°. The distance to the closest northern building of the inner circle is approximately 18 m, to the south it is approximately 35 m. Along its length, the anomaly of the 'mega-structure' is divided into three parts. The first (east) and third (west) are represented by an even image, which usually corresponds to remains of burnt clay. They occupy 24% and 59% of the building's length respectively. The central part is the smallest – 17% of the building's length. The magnetic anomaly is almost absent here. Therefore, we can assume the division of the building's inner space into at least three rooms.

From the results of geomagnetic survey, we can also assume the internal spatial division of other buildings at the settlement into separate rooms. Using first-category buildings as an example, we see the inner division into two rooms. The first of them is usually smaller and is represented by a weak anomaly. It is 28–42% of the building's total length. The smaller size of these room is the reason for interpreting them as the entrance part of the building. The second room is larger and is represented by a strong anomaly, and so is considered as the main room of the building.

Using one anomaly of the second-category building as an example, which is on the southern part of the inner circle, we assume the division of the building into three parts along the length. The areas of the southern and central part are almost

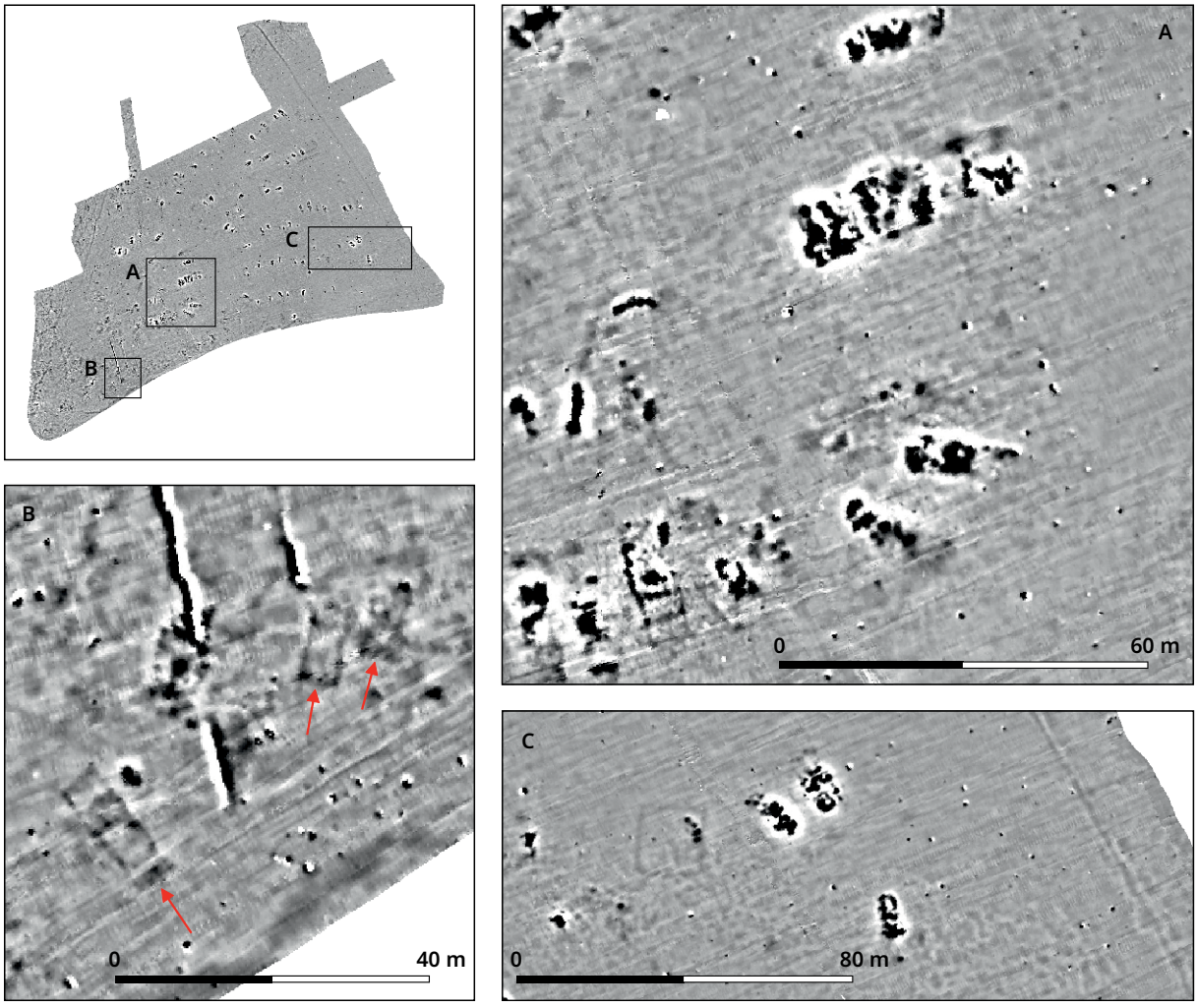


Figure 88. Vilshanka: details of the magnetic map and locations within the settlement; A. part of the inner concentric row of buildings, with the mega-structure and buildings of the southern part of the row; B. southwestern part of the settlement with the anomalies of the buildings' contours; C. part of the radial row of the buildings, with the quadrangular anomaly and the linear anomaly of the ditch.

equal and occupy approximately 17% of the total length each. The northern part occupies the remaining 66% of the building's length.

The areas of the anomalies which were interpreted as buildings range from 13 to 220 m^2 (Tab. 15; Fig. 89). The most common are buildings with an area of up to 50 m^2. The share of buildings of this size is almost 53%. They are located all over the settlement, but their main cluster is within the radial rows. All the buildings in the eastern part of the outer circle, which are generally at the end of the radial rows, also have an area of <50 m^2. The share of the next group, buildings with an area of 51–100 m^2, is almost 40%. Most of these buildings are found in the western part of the settlement; some are also located within the radial rows. Within these buildings with an area of 51–100 m^2 we found most of the buildings divided into two rooms. Seven buildings (6.61%) in the settlement with an area of 101–150 m^2 are located within the concentric rows and in the cluster to the south-west of the outer row. This means that all of them are located in the western part of the settlement. The western part of the inner row contains the building 220 m^2 in size which is located opposite the mega-structure. Buildings with an area of 151–200 m^2 are absent from the archaeomagnetically examined part of the settlement.

Within the second radial row (counting from the south) the square anomaly is located (Fig. 88), which is not typical for CT. Much like the second-category buildings we find a weak anomaly of contours of this atypical feature which has a size of 16.0 × 16.5 m. In the north-east corner of the square structure, we find a

Area (m2)	Number of buildings	Percentage of buildings (%)
13–50	56	52.83
51–100	42	39.62
101–150	7	6.61
151–200	0	0
220	1	0.94
13–220	**106**	**100**

Table 15. Vilshanka: number and percentage of the buildings at the settlement grouped by area in steps of 50 m².

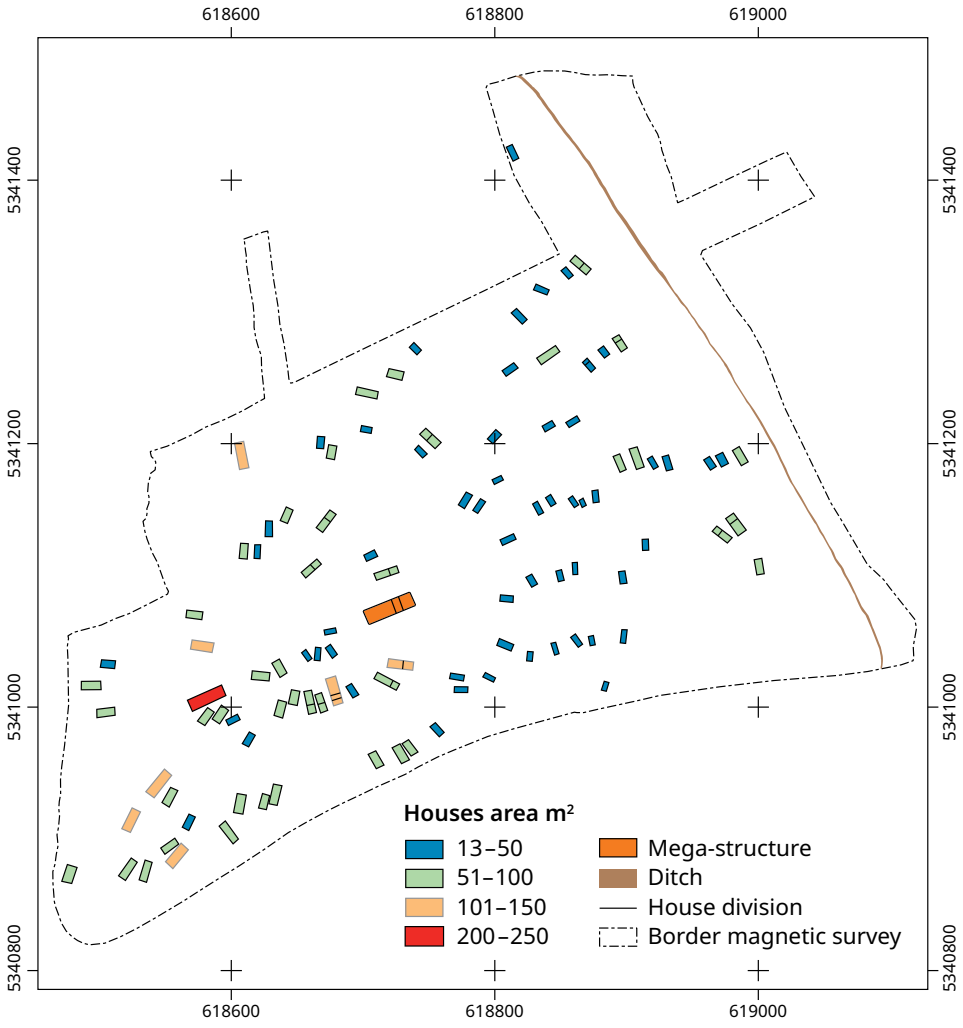


Figure 89. Vilshanka: location of the buildings categorised by their floor size.

better visible anomaly, which has an oval-like form and stretches in a north-south direction over an area of 6.9 × 2.6 m.

The anomalies of geological features greatly complicate the marking of the pit anomalies. It is important to say that the specifics of deepened features at such settlements, located on rocky areas, are not completely understood. During the interpretation of the Vilshanka settlement anomalies we carefully identified 14 of these, which may be the pits from the Trypillia period. They are mostly located not far from the edges of the buildings within the inner circle and radial rows.

Seven anomalies of round or oval features with diameters of 2.4–2.7 m are preliminarily interpreted as kilns or pits filled with daub from the wood-clay buildings. The maximum value of the magnetic flux density of these features is

generally 30–50 nT. These features are located in various parts of the settlement, 4–9 m away from the building anomalies, or further away from other features.

Therefore, at the core of the settlement planning are two concentric rows of buildings with the ring-corridor between them. In the north-east part of the outer row a mega-structure is located. To the east of the outer circle, the buildings are located in radial rows. The territory of the settlement to the east of the rows is enclosed by the ditch. A peculiarity of the settlement is very small building anomalies – the area of 23 of the buildings is less than 30 m^2. It is possible that the settlement had kilns.

Excavation

While examining the walls of the quarry, which is located on the south-west edge of the settlement, we discovered three deepened features, which were damaged by stone extraction (Fig. 86). Two of them were located near one another, so their section was documented by Profile 1. The third one was 30 m away from them to the north. Its section was documented by Profile 3.

Profile 1, Pits 1 and 2

Profile 1 is located 5.8 m to the west of the magnetically scanned area (Fig. 90). The approximate distance to the outer concentric row is 41 m. The width of the cleaned area of the profile is 3.2 m, the depth is 1.2 m. The natural stratigraphy within the profile is represented by two layers. Above is the Chernozem layer 30–35 cm thick, with pieces of different-sized natural stones. Below it is an inhomogeneous natural layer consisted of layers of stone and sand. The modern surface level is at 169.64–169.65 m asl.

Pit 1 has vertical walls and a flat bottom. Its depth below the modern surface is 95 cm, meaning it goes 65 cm down into the natural layer; its width is 80 cm. The filling of the pit consist of brown-yellow soil. The filling contains single fragments of ceramics, animal bones and natural stones.

Pit 2 has a vertical northern wall; the southern wall is sloping. The width of the pit is 1.4 m, the maximum depth in the northern part is 83 cm below the modern surface. The upper northern part of the pit is filled with black-grey soil. The artefacts in this layer can be found 20 cm below the modern surface. The rest of the pit is filled with brown-yellow soil. The artefact filling is analogical to Pit 1.

Since the distance between the pits is only 30 cm and their filling is similar, we assume that the pits were connected in the upper part, so that Pits 1 and 2 could have been parts of one large pit. The bottom of both pits goes into natural compact stone layer. Therefore, this complicated the further deepening of the pit in the Eneolithic Age. The upper line of the artefacts located in Pit 2 possibly marks the level of the ancient earth surface.

Profile 2, Pit 3

Profile 2 is located 2 m to the west of the edge of the magnetically scanned area and 24 m away from the closest building of the outer concentric row (Fig. 86). The width of the cleared area of the profile is 2.4 m, the depth is 1.4 m (Fig. 91). The stratigraphy of the natural layers is analogical to Profile 1. The modern surface is at a level of 169.82–169.83 m asl.

Only the southern part of the pit was cleaned all over the profile. Its southern wall is sloping gently down into the flat bottom. The maximum depth of the pit is 94 cm from the level of the modern surface. The upper part of the pit is filled with black-grey soil, while in the lower part the soil is dark-brown. The filling of the pit contains single fragments of ceramics, animal bones, natural stones and an anthropomorphic figurine.



Figure 90. Vilshanka: photo of Profile 1 displaying the filling of Pits 1 (left) and 2 (right). View from the west.



Figure 91. Vilshanka: photo of Profile 2 displaying the filling of Pit 3. View from the west.

This pit appears to have been dug to obtain easily accessible building materials as well the Pits 1 and 2; the bottom of the deepened feature lies on the compact natural layer.

^{14}C dating

From the backfill of the three pits documented at the edge of a stone quarry in Vilshanka, a total of six ^{14}C dates were obtained from bone samples (Suppl. 1 in Chapter 19, this work, Vol. II). The Poz-97900 date is derived from Pit 1 and, with a median of 4160 BCE, dates to the period between 4241–4060 BCE (68.3%) and 4317–4049 BCE (95.4%; Fig. 92).

The two consistent dates Poz-97901 and Poz-97902 were obtained from Pit 2, one from a cattle bone and one from a pig bone. According to a simple Bayesian model with boundaries at the beginning and the end, the backfilling of this pit dates with the highest probability between 4220 and 4040 BCE (Tab. 16; Fig. 93).

From cattle bones recovered from Pit 3, the three dates Poz-97903, Poz-97905 and Poz-97913 were obtained. According to a Bayesian model using the Boundary function, the backfilling of the pit most probably falls between 4230 and 4050 BCE (Tab. 17; Fig. 94).

Krynychky-Ferma

Research history

The settlement was discovered by EPAE fieldwalking in May 2015 during the settlement search around Kisnytsia village (Horodkivka territorial community, Tulchyn Raion), as reported by local historian B. H. Vitsa (1992). The expedition examined the territory of the newly-discovered settlement and determined the area of the artefacts distribution (Rud *et al.* 2016). In cooperation with CAU and IA NASU, a magnetic survey of the settlement was carried out in spring 2017, and test excavations of two trenches were carried out in the summer.

Geographical position

The Krynychky-Ferma settlement (48°24’41.6”N, 28°44’53.8”E) is located on the eastern outskirts of Krynychky village in the Horodkivka territorial community, Tulchyn Raion. From a topographical perspective, the settlement occupies the flat part of the plateau, which is approximately 30 m above the valley of the stream which runs to the west from the site, through the centre of Krynychky village. The stream is the left tributary inflow of the Markivka River (stream→Markivka→Dniester). The north-west facing earth’s surface slopes slightly within the settlement (Fig. 95).

Most of the settlement’s territory is located on the field of homogeneous annual crops. These cover the central, northern and eastern parts of the settlement. The southern edge of the settlement is occupied by the grass-covered terrain of the mostly destroyed farm. The western part of the settlement is crossed by the road which goes to Kisnytsia village. The western edge of the settlement is occupied by households of Krynychky village residents.

Magnetic survey

The archaeomagnetic survey was conducted at the Krynychky-Ferma settlement over an area of 9.9 ha. Anomalies of the archaeological features were found over an area of almost 8 ha (Fig. 96). The survey covered most of the settlement’s territory.

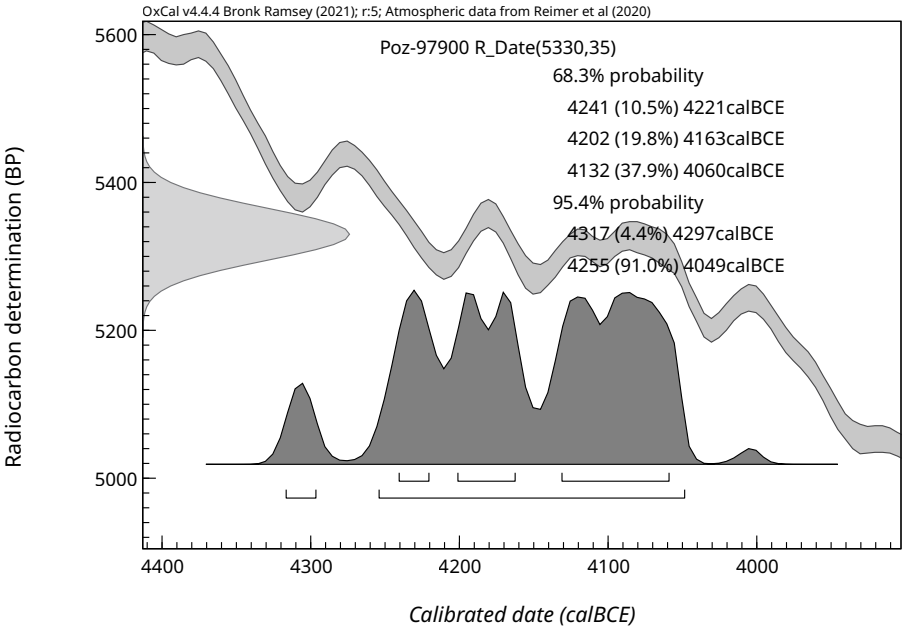


Figure 92. Vilshanka: calibration plot of the dating Poz-97900 from Pit 1.

	Dating range 68.3%	Dating range 95.4%	Median	Highest dating probability
Start	4329–4050	4924–4007	4007	4220 or 4160
Duration	0–413	0–1291	222	120 or 180
End	4207–3878	4223–3224	4001	4040

Table 16. Vilshanka: results table of a Bayesian model of the backfilling process of Pit 2. A_{model}=103.3; $A_{overall}$=102.6. All boundary dates in BCE, duration in years.

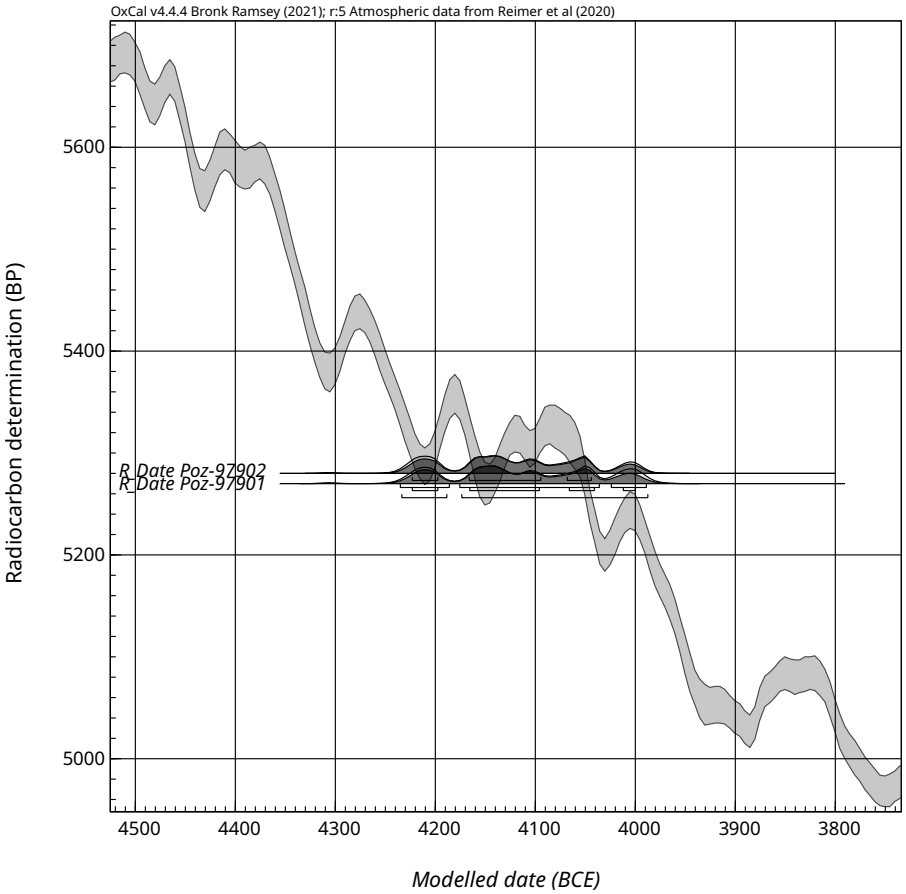


Figure 93. Vilshanka: curve plot of two modelled ^{14}C dates from the filling of Pit 2.

	Dating range 68.3%	Dating range 95.4%	Median	Highest dating probability
Boundary start filling	4294–4096	4924	4221	4230
Duration	0–245	0–895	148	180
Boundary end filling	4162–3964	4231–3636	4054	4050

Table 17. Vilshanka: results table of a Bayesian model of the backfilling process of the Pit 3. A_{model}=98.8; $A_{overall}$=99.2. All boundary dates in BCE, duration in years.

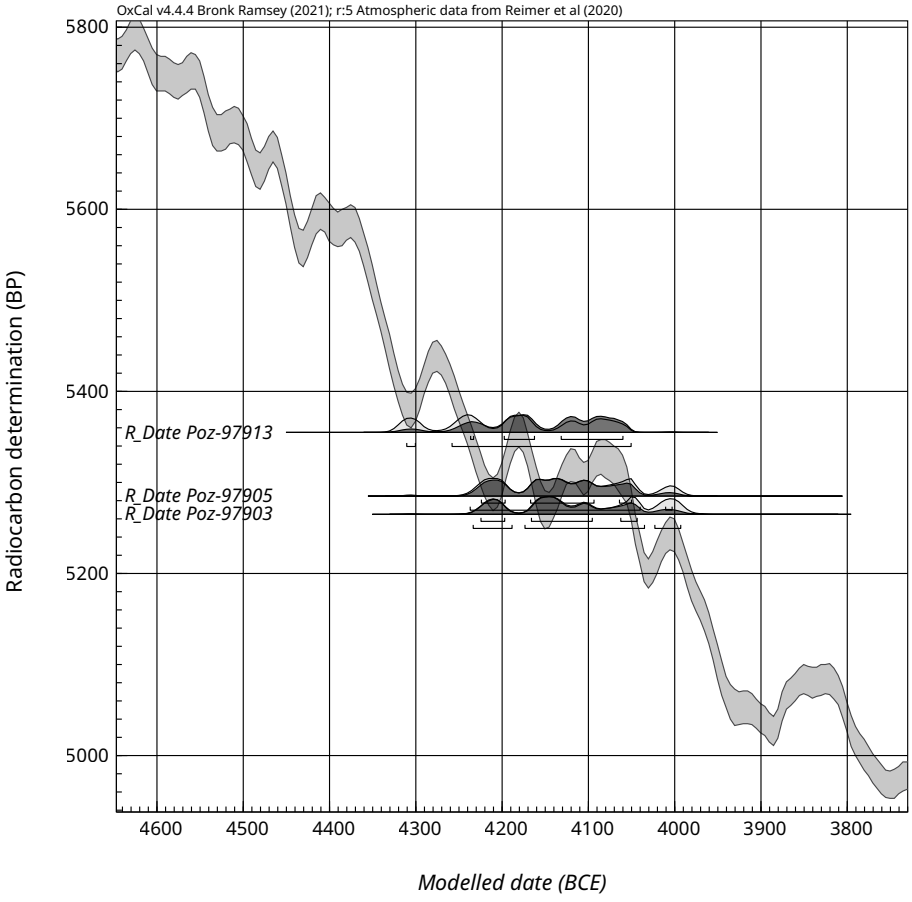


Figure 94. Vilshanka: curve plot of three modelled ^{14}C dates from the filling of Pit 3.

Western and southern parts of the settlement occupied by nearby village residential gardens, trees and bushes, and farming areas, were not included in the scanned area. Taking into consideration the topographical situation, the total area of the settlement is presumed to be no more than 14 ha.

The magnetic map is difficult to interpret due to the unsystematic locations of the small anomalies. The result of the scanning resembles unclear magnetic maps of CT settlements seen in Romania (Hofmann *et al.* 2016). Following the methods used in that publication, the interpretation of the magnetic map of Krynychky-Ferma was made after categorising the anomalies according to their magnetic flux density value, which gives eight classes of anomalies, ranging from 1 to over 100 nT (Fig. 97).

Following the analysis of the anomalies and also considering the results of the surface find collections and excavations, we identified seven clear rectangular anomalies of burnt wooden-clay buildings. We also assume the existence of 18 more buildings of the same type, the anomalies of which are less clear. The buildings on the settlement form a concentric row 140 m in diameter. The anomalies are practically absent to the north and north-east of the row, which indicates the existence of the ring-corridor 50–60 m wide. Several buildings are located to the north and south-east of the corridor. The area of the ring-corridor is occupied by small anomalies.



Figure 95. Krynychky-Ferma, view of the site from the south-east. Photo taken during magnetic survey of the site in March 2017.

Considering the area of the settlement and the number of buildings, the density of the latter is small. The cluster of seven buildings was located in the northern part of the concentric row. Other areas of the circle are mostly represented by weak anomalies of small features and anomalies of possible buildings.

The area of anomalies which were interpreted as buildings varies from 42 to 222 m^2 (Tab. 18). The biggest building in the settlement is located in the north-east area; its area is 222 m^2. Another building which is 190 m^2 in size is 1 m away and parallel to it. Its long axis' azimuth is 40º. There are no anomalies of other features nearby, which is typical for plazas. The separated location, the area and the direction of these buildings may indicate that we are dealing with mega-structures (Fig. 98).

Some of the weak anomalies (mostly less than 20 nT) in the south and east parts of the concentric row display linear and rectangular structures, which initially were interpreted as building anomalies. However, the results of the excavations (see below) suggest otherwise.

Based on the results of Trench 1 investigation we cautiously interpret magnetic anomalies up to 5 nT at the settlement as pits with small amounts of artefacts. The anomalies over 5 nT in magnetic flux density value are probably the results of the active household activities of the settlement's inhabitants. Most of them are 5–10 nT in magnetic flux density value and, based on the excavation results (Trench 2), are probably deepened features, the filling of which took place (at least partly) during the settlement's occupation.

Of considerable interest are the round anomalies 3 m in diameter, the magnetic flux density value of which is 20–75 nT. They are located in the southern part of the settlement, which is mostly occupied by small anomalies of pits. Taking the interpretation from previous magnetic plans (Talianki, Nebelivka, Maidanetske: Kruts *et al.* 2011; Korvin-Piotrovskiy *et al.* 2016; Videiko *et al.* 2015; Müller and Videiko 2016) we have assumed that round anomalies from Krynychky-Ferma are



Figure 96. Krynychky-Ferma: magnetic plan of the site against the background of the Google satellite image.

kilns for pottery firing. Considering their number (almost two dozen) we are dealing with a settlement which was perhaps oriented towards pottery production.

On the other hand, the excavations established that the natural soil within the settlement is sandy and unsuitable for the pottery production. Judging by the ceramic findings, pottery was made of clay without sand. The location of the production facility, which is currently represented by the anomalies of the kilns in an area lacking raw materials, seems illogical. Therefore, there must be another interpretation for these anomalies. Analogical round anomalies are also formed by pits filled with large amounts of daub (Müller and Videiko 2016) or clay installations. Wide-ranging excavations are required for a better understanding of the structure and domestic functioning of the settlement.

The contour of the rectangular anomaly (7.8 x 6.3 m) with a gap in the centre of the north 'wall' is located on the north-east outskirts of the settlement. Two weaker anomalies of a similar configuration are located to the south-east. The features are not typical for Trypillia settlements and may indicate a later habitation of the territory.

Therefore, the core of the settlement plan is interpreted to be the small number of buildings that together with sunk features form a circular row with a few buildings situated outside it. Some kind of unoccupied circular corridor around the row is also documented. The area to the south of the row is mostly occupied by small anomalies that could be pits or other small household features. In any case, the settlement structure of the Krynychky-Ferma site is not as regular as the structure of settlements in the preceding Trypillia periods.

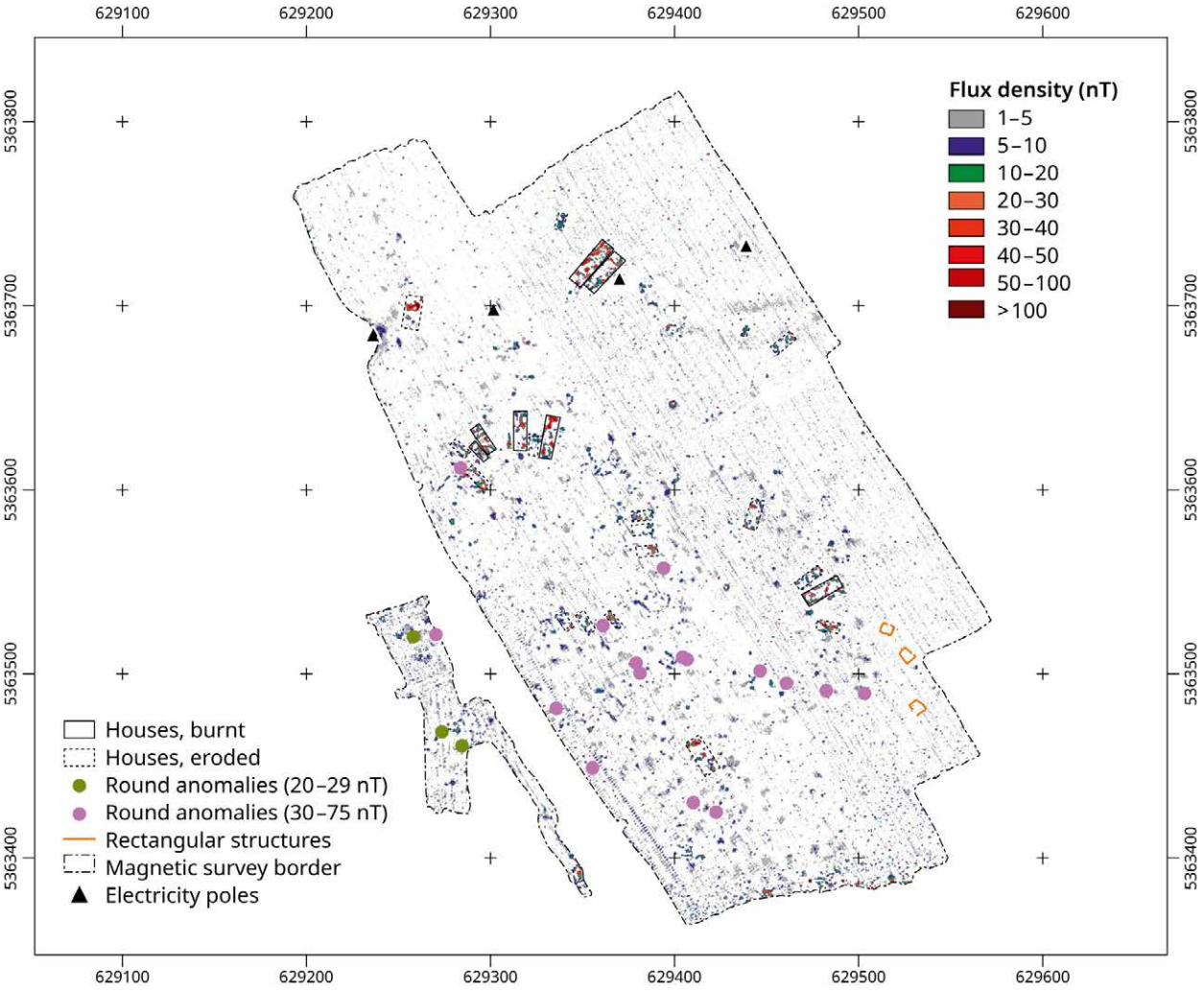


Figure 97. Krynychky-Ferma: interpretation of the magnetic features.

Area (m²)	Number of buildings	Percentage of buildings (%)
42–50	4	16.66
51–100	12	50.00
101–150	1	4.17
151–200	6	25.00
222	1	4.17
42–222	24	100

Table 18. Krynychky-Ferma: number and percentage of buildings at the settlement grouped by area in steps of 50 m².

Excavation

From the results of the magnetic plan, excavations of two magnetic anomalies were conducted. Trenches 1 and 2 were located on the features of the settlement's circular row (Fig. 98), in its south-eastern part. The trenches are located 4.3 m apart.

Trench 1, ancient surface and a pit

Trench 1 which is (2 × 3 m in size) was located in order to examine the northern part of the weak anomaly (<5 nT) which is approximately 9 × 6 m in size. It appeared to be the anomaly of the large deepened feature on the magnetic plan, stretching along a north-west/south-east line.

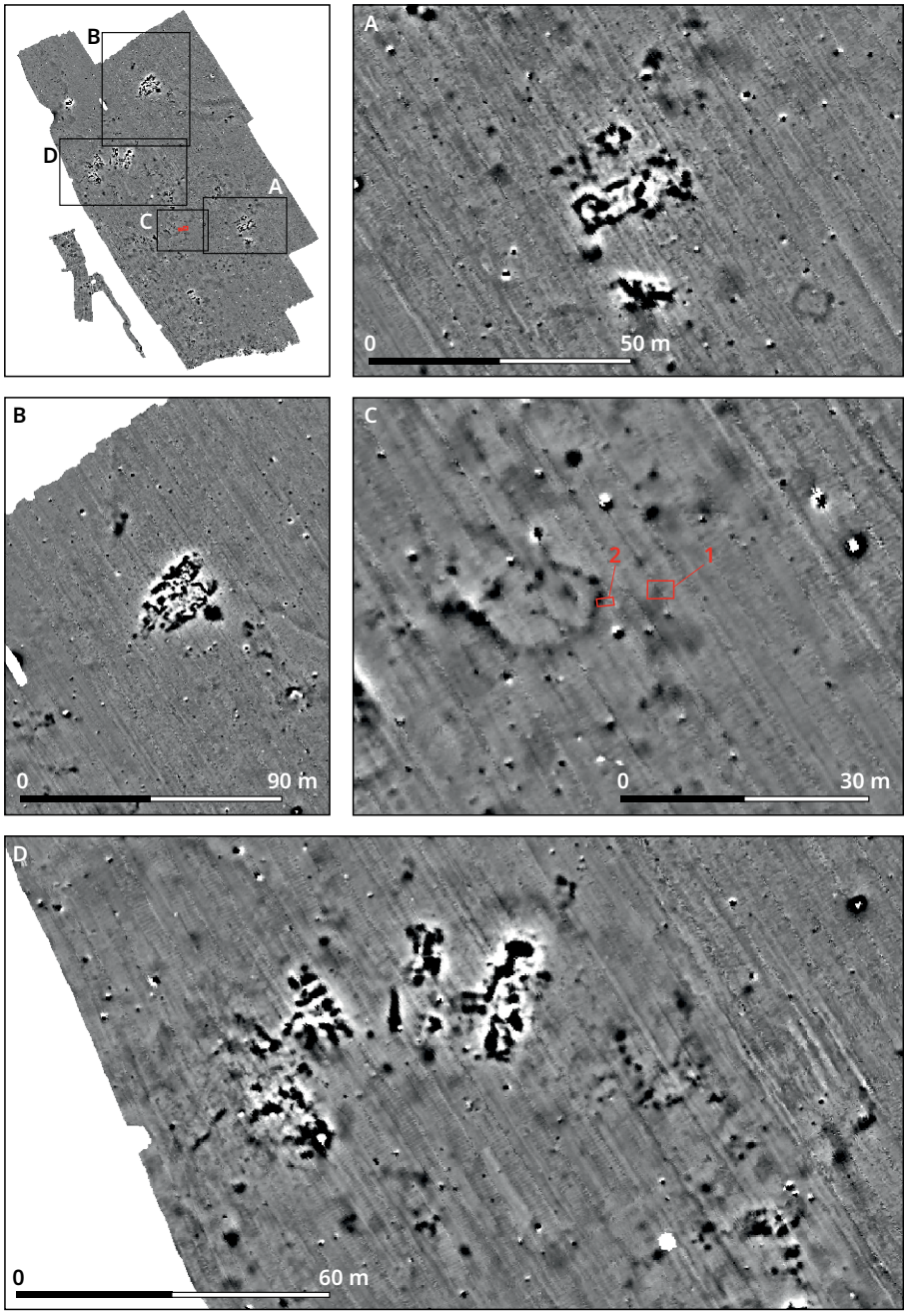


Figure 98. Krynychky-Ferma, details of the magnetic map and its locations within the settlement; (A) anomalies of buildings and rectangular structure to the south-east of the ring-corridor; (B) north-eastern buildings, probable mega-structures; (C) anomalies in the southeastern part of the concentric row and location of Trenches 1 and 2; (D) buildings in the northern part of the concentric row.

The Chernozem layer (1001) covered a dark grey-yellow layer of soil (1002) in which, at the level of 309.61–309.63 m asl all across the trench, separated fragments of pottery were found, as well as bones up to 10 cm in size, as well as a large stone which marks the level of the ancient surface (Fig. 99). There is natural layering within Trench 1, with a large added amount of sand and very small stones.

In the south-west corner of the trench, on the level of Planum 2, a deepened feature (1003) was recorded (Fig. 99). The filling of Pit 1003 was homogeneous and consisted of black-grey soil in which a large amount of pottery fragments, animal bones and daub was found. Since the clay mass of the daub contains very small stones, it is obvious that the building within the settlement was constructed using local sandy soils. The deepest part of the pit within the trench was found at the level

of 308.94 m asl, meaning that the pit was dug into the sandy loam (1004) and loess (1007) to a depth of almost 0.7 m (Fig. 100).

Trench 2, pit

To the east of Trench 1, Trench 2 is located, and it is 1 × 2 m in size. Its aim was to determine the nature of the rectangular structure which was located within the circular row (Fig. 98). Before the excavation it had been suggested that such structures, formed by the sequentially arranged line of anomalies, were the ruins of houses.

Two compact layers of Chernozem (2001, 2002) with a total thickness of 73–100 cm covered the cluster of artefacts (2003; Figs. 101, 102). In the upper layer (2001) there were almost no finds, excluding single fragments of clay crumb. The lower layer contained single fragments of daub (<1 cm) and ceramic pottery

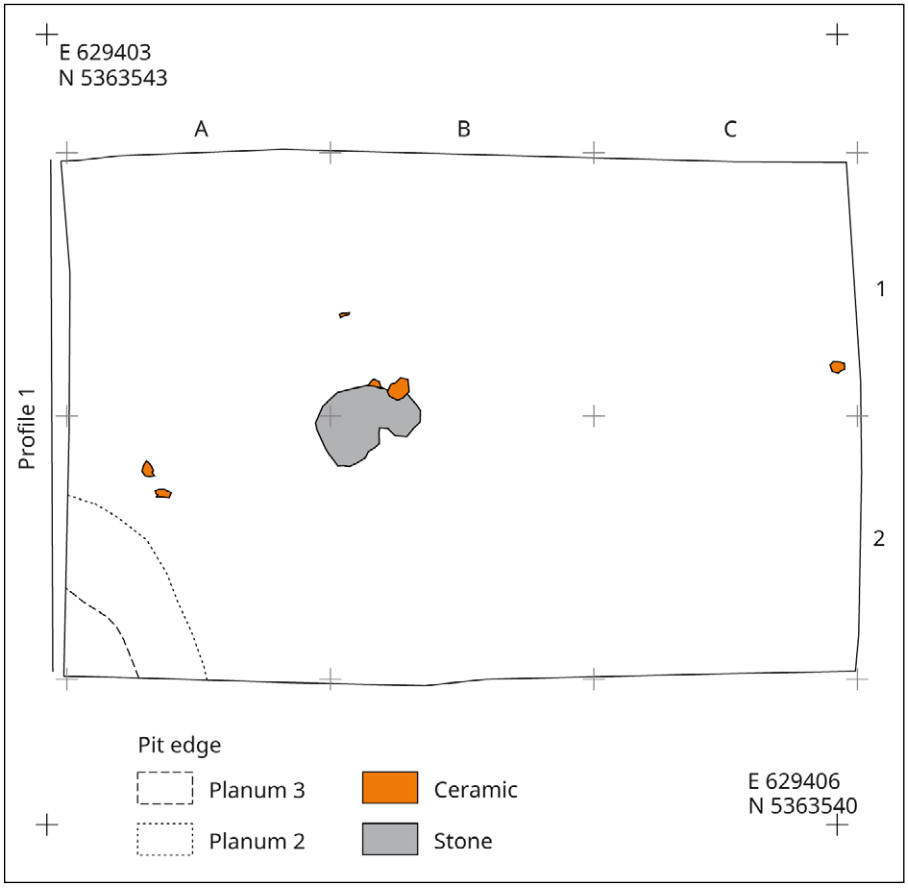


Figure 99. Krynychky-Ferma, Trench 1: position of artefacts at the level of Planum 1 (309.61–309.63 m asl) and the border of the pit at the level of Planum 2 (309.38–309.41 m asl) and 3 (309.18 m asl). Location of Profile 1.

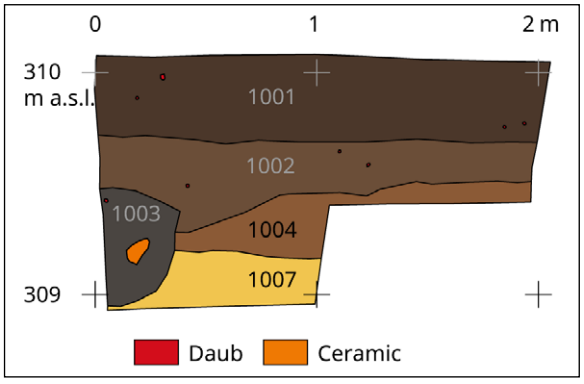


Figure 100. Krynychky-Ferma, Trench 1, Profile 2: 1001 – black-grey; 1002 – grey-yellow, dark; 1003 – black, greyish; 1004 – grey-yellow; 1007 – yellow-grey.

Figure 101. Krynychky-Ferma, Trench 2: Planum 1 displaying the pit filling

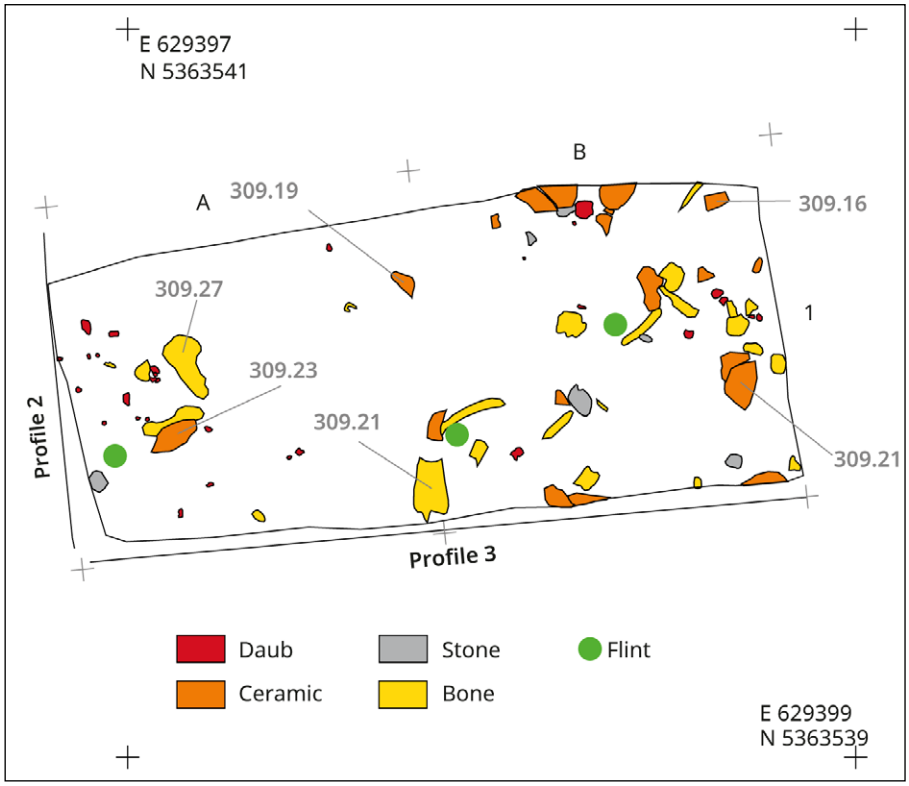


Figure 102 (below).Krynychky-Ferma, Trench 2: photo of Planum 1 displaying the pit filling.



(<3 cm). Layer 2003 was filled with a large amount of artefacts, including fragments of animal bones and ceramic 15–20 cm in size, flint and horn tools, and ceramic figurines (Fig. 103). The finds are located in a compact layer which is spread all over the test trench. They are located in black-grey soil with a yellowish shade. The thickness of the layer varies in different areas from 10 to 30 cm (Figs. 104, 105). The yellow-grey loess layer is below this. The soils of all the contexts in Trench 2, as well as Trench 1, are compact and sandy.

The deepest part of the Context 2003 was found at a depth of 309.05 m asl. Considering the inclined slope (approx. 10 cm) of the modern surface between the trenches and the level of the ancient surface which was found within Trench 1, we assume that in Trench 2 we also investigated part of a pit. The finds (Context 2003) are located at the bottom of the pit; the depth of the pit is also approximately 0.7 m.

^{14}C dating

From bones (mostly cattle) recovered in Trenches 1 and 2, a total of five ^{14}C dates were obtained (Suppl. 1 in Chapter 19, this work, Vol. II). The three dates from



Figure 103. Krynychky-Ferma, Trench 2: photo of the broken horn hoe in the pit.

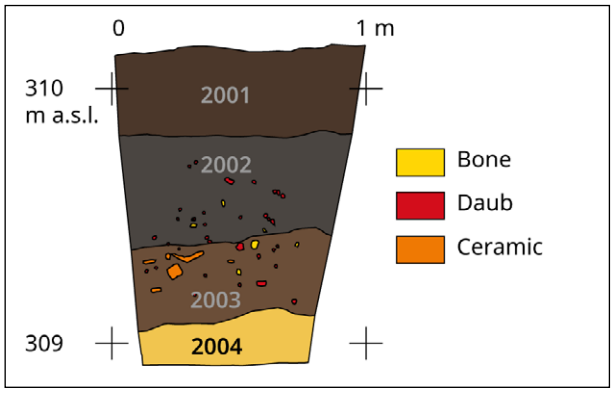


Figure 104 (bottom left). Krynychky-Ferma, Trench 2, Profile 2: 2001, 2002 – black-grey; 2003 – black-grey, yellowish; 2004 – yellow-grey.

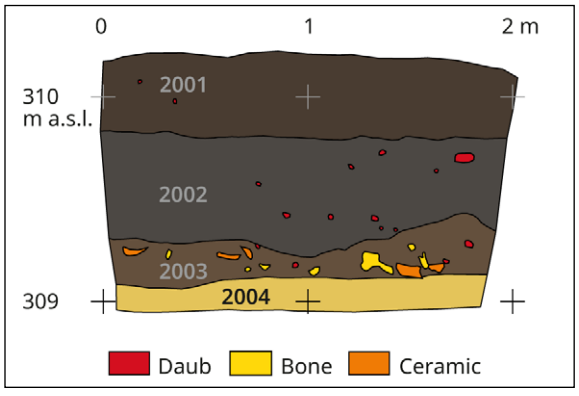


Figure 105 (bottom right). Krynychky-Ferma, Trench 2, Profile 3: 2001, 2002 – black-grey; 2003 – black-grey, yellowish; 2004 – yellow-grey.

Trench 1 originate from the old surface (Feature-ID 1002) adjacent to the pit (Poz-97906) and from two successive layers of pit backfill (Poz-97907, Poz-97908). According to a Bayesian model with two successive phases, the filling of the pit most probably took place between 3620 and 3530 BCE (Tab. 19; Fig. 106).

The two dates Poz-97909 and Poz-97911 were recovered from two successive backfill layers of the pit investigated in Trench 2. According to a Bayesian model with two successive phases, the filling of the pit most probably took place between 3640 and 3530 BCE (Tab. 20; Fig. 107).

Table 19. Krynychky-Ferma: Bayesian model of the backfilling process of the pit investigated in Trench 1. A_{model}=122.2; $A_{overall}$=121.5. All boundary dates in BCE, durations in years.

	Dating range 68.3%	Dating range 95.4%	Median	Highest dating probability
Boundary start lower filling	3650–3563	3819–3528	3619	3620
Duration	0–60	0–246	30	40
Boundary lower-upper filling	3602–3550	3626–3535	3578	3580
Duration	0–47	0–148	25	50
Boundary end upper filling	3581–3513	3631–3436	3543	3530

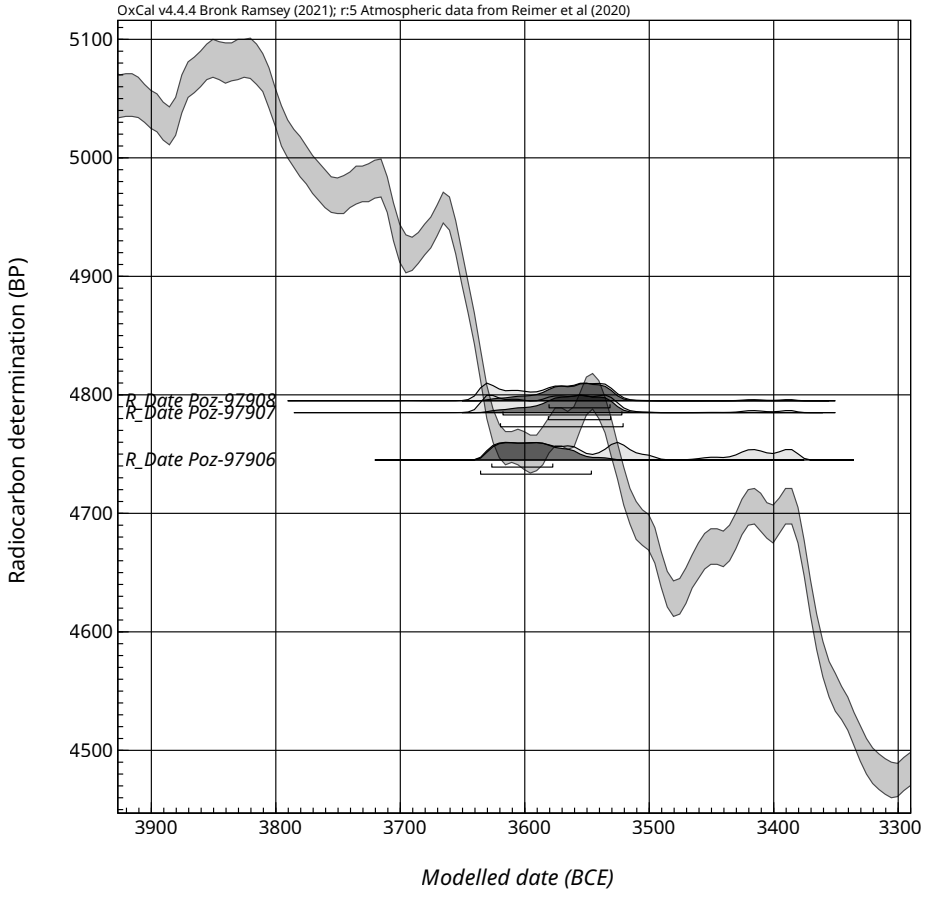


Figure 106. Krynychky-Ferma: curve plot of three modelled ^{14}C dates from the pit in Trench 1.

Kisnytsia

Research history

The settlement was discovered in the 1980s or beginning of the 1990s by the local historian B. H. Vitsa (1992). A more detailed investigation of the site was conducted by M. V. Potupchyk in 2003, who noted that the northwestern part of the site had been destroyed by stone-processing activities (Potupchyk 2003, 22). In spring 2017 CAU and AI NASU conducted a joint investigation of the settlement's territory. The localisation and direction of wooden-clay buildings damaged by agricultural activity were documented using GPS equipment. In spring 2018 a magnetic survey of the settlement was conducted as well as test excavations of one anomaly, based on the results of the survey. The results of these investigations, including a selection of finds, were recently published (Rud *et al.* 2023). According to this, settlement activities repeatedly took place here during the periods Trypillia C1 and C2.

	Dating range 68.3%	Dating range 95.4%	Median	Highest dating probability
Boundary start lower filling	3706–3623	3949–3529	3649	3640
Duration	0–82	0–384	38	10
Boundary lower-upper filling	3643–3535	3676–3517	3599	3630
Duration	0–82	0–364	39	100
Boundary end upper filling	3631–3506	3642–3233	3539	3530

Table 20. Krynychky-Ferma: Bayesian model of the backfilling process of the pit investigated in Trench 2. A_{model}=104.2, $A_{overall}$=104.1. All boundary dates in BCE, durations in years.

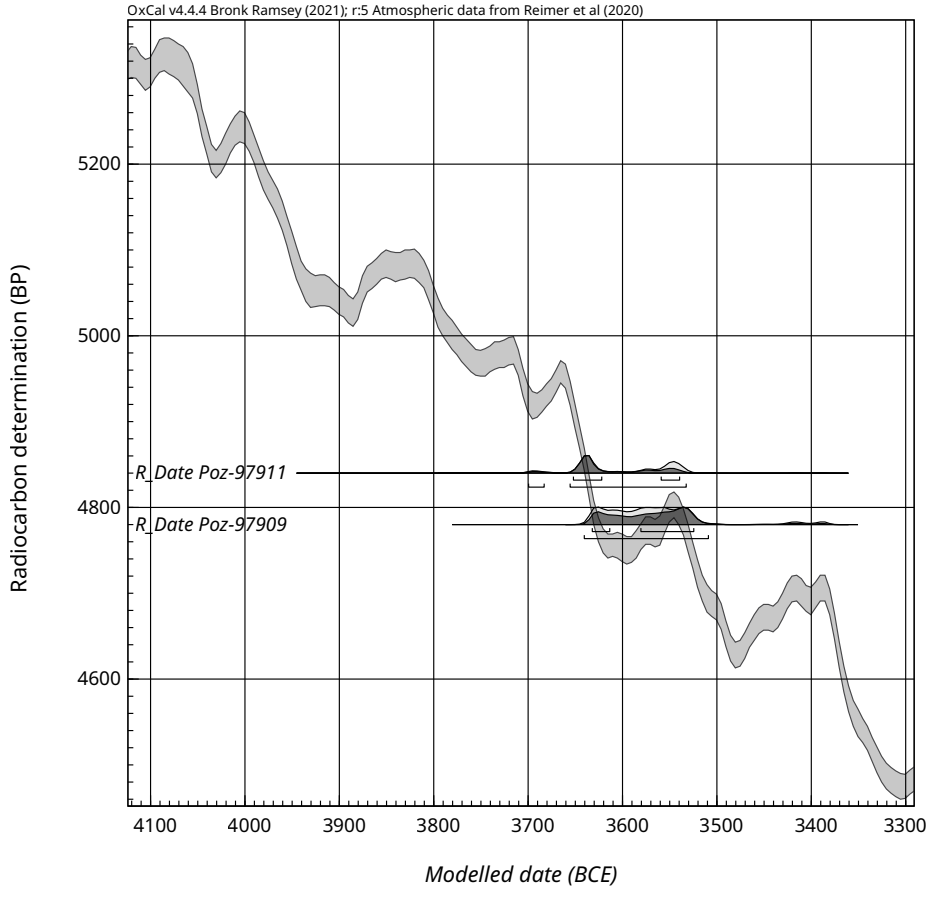


Figure 107. Krynychky-Ferma: curve plot of two modelled ^{14}C dates from the filling of the pit investigated in Trench 2.

Geographical position

The Kisnytsia site (48°25'47.6"N, 28°45'29.4"E) is located on the eastern outskirts of Kisnytsia village in the Horodkivka territorial community of Tulchyn Raion. It is situated on the promontory of the left bank of a small river that flows in a southerly direction through the village and into the Markivka River (a tributary of the Dniester River). The promontory is formed by a bend in the river and a dry valley (arroyo) that slopes into the river to the left. Therefore, the river is to the north and west of the site, while the arroyo is located to the south. The promontory's height increases from the west to the east; the difference in elevation across the site is 27 m, so that the western part of the site is 18 m above the water level of the river. The surface of the promontory within the site has a mostly north-western exposure. Most of the site's territory is located on an open field; only its western edge is covered with small bushes, and the north-western edge is forested.

Magnetic survey

The magnetic survey of the settlement was conducted over an area of 8.7 ha (Fig. 108). Over almost all the area, archaeological features were discovered, excluding the areas to the north and south of the settlement, which are mostly located on sloping areas. Considering the area of the promontory to the west of the area investigated, which may also contain archaeological features, the area of the settlement is approximately 6.5 ha.

Based on the magnetic survey only a part of the anomalies found can be interpreted, including (Fig. 109):

- 22 rectangular anomalies, which appear to be the ruins of burnt wood-clay houses.
- 27 rectangular anomalies of buildings, burnt with less intensity or eroded.
- Numerous anomalies of pits.

We considered three zones in the settlement structure: western, central and eastern.

In our opinion, in the western zone residents tried to create the settlement according to the classical Trypillia scheme. This means that the planning was based on two concentric circles of buildings and the ring-corridor between them, free of buildings. However, within the western zone of the Kisnytsia settlement only two semicircles of buildings were discovered separated by the 22–40 m wide corridor, which is free of buildings. In addition, the space within the inner semicircle is free of buildings. However, a small number of small anomalies, which are probably deepened features, are still located both within the corridor and within the inner semicircle.

The line of the buildings, accompanied by randomly located pits, is located to the north of the western zone semicircles.

The large amount of pits is, in our opinion, a specific feature of the central zone of the settlement. The large number of small anomalies are considered to be pit. They rarely correspond clearly to the outlines of a defined geometric figure. Only oval or circle-like forms can sometimes be seen in the shapes of such pits. The maximum area of one feature, which can be considered as a pit, is nearly 28 m^2, the typical area is 5–7 m^2. The magnetic flux density value of the most of the anomalies is no more than 5 nT. The maximum value of some of the anomalies is 5–10 nT. There is no visible strategy in the arrangement of the pits at the settlement, they can be found both near the edges and long walls or in groups at a certain distance from buildings. The only system that we can see, especially in the central zone of the settlement, is that the bigger pits are located near to the buildings.

16 buildings with different vectors are located in the central zone of the settlement. Very tentatively, we assume that 15 buildings form a circle. In the centre of the circle is one building. This would mean that the inner space of the circle is free of dense building, however it is occupied by numerous anomalies of pits.

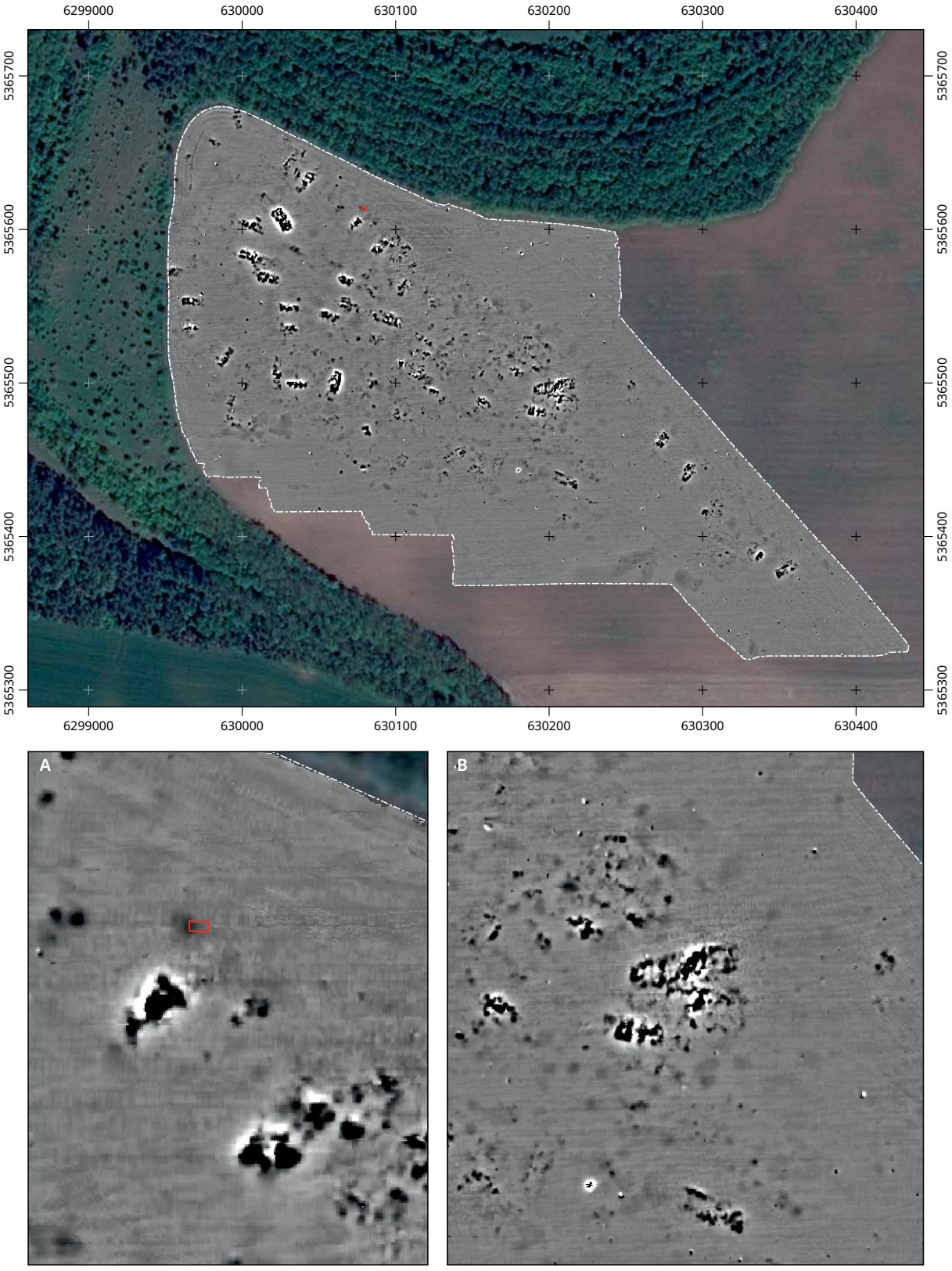


Figure 108. Kisnytsia: magnetic plan of the sites against the background of the Google satellite map. Details of the magnetic map and its locations within the settlement; (A) anomalies in the northern part of the site and the location of Trench 1; (B) central part of the site and the anomaly of the largest structure.

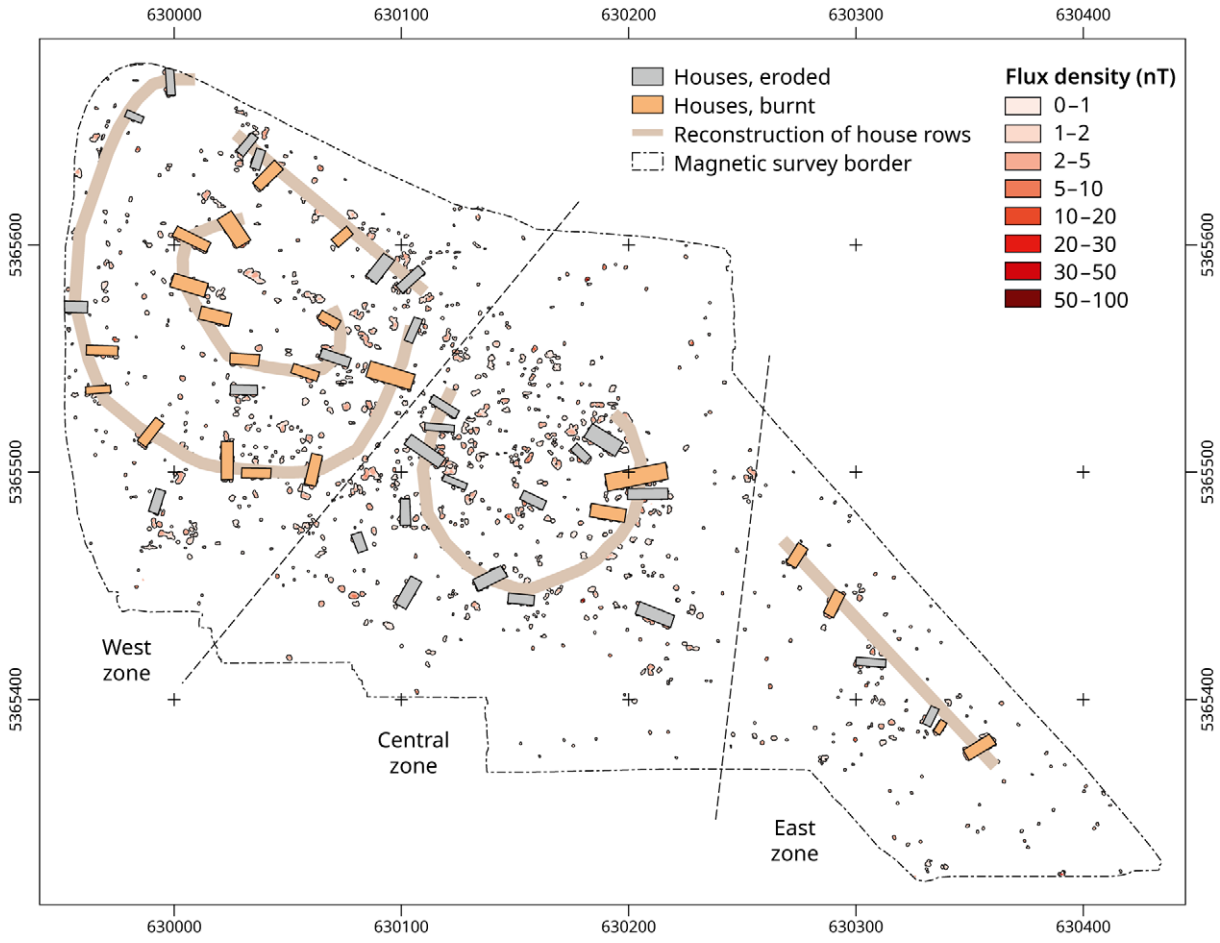


Figure 109. Kisnytsia: interpretation of the magnetic features and the reconstruction of house rows within site zones. Most of the low-flux density anomalies outside the houses are pits.

The eastern zone of the settlement is formed of six building anomalies, surrounded by pits. The buildings are arranged in a row, parallel to the edge of the flat part of the plateau, oriented in a north-west/south-east direction. The westernmost building of the eastern zone is 58 m away from the buildings of the central zone. The space between them contains a small number of pit anomalies.

The areas of the anomalies which were interpreted as buildings range from 19 to 203 m^2. In the system of the buildings' location, grouped by area in steps of 50 m^2 (Tab. 21), we can see the following (Fig. 110). The most commonly sized buildings (more than 57%) have areas of 51–100 m^2. They are located all over the settlement. The buildings with areas of less than 50 m^2 are equally spread within all zones of the settlement. The percentage of these is more than 34%. Three buildings with areas of 101–150 m^2 are located within the western and central parts of the settlement, along the topographically highest parts of the promontory. In the north-east part of the central zone of the settlement there is the largest building, which has an area of 203 m^2. It is located on the prominent position of the promontory.

Previous research of the Kisnytsia settlement has stated that the settlement territory is enclosed by a one metre high rampart on the east and a ditch 0.7 m in depth (Potupchyk 2003, 22). However, the results of the magnetic survey show no signs of such features. Visual examination of the settlement's territory did not discover them, either.

Therefore, the planning structure of the settlement is not completely clear. Preliminary processing of ceramic materials found during surface find collection the territory of the site and in the Trench 1 indicates that the Kisnytsia site was successively inhabited in the Copper Age – during the CI and CII stages. It appears that the settlement was initially planned in two circles with the ring-corridor

Area (m2)	Number of buildings	Percentage of buildings (%)
19–50	16	34.04
51–100	27	57.45
101–150	3	6.38
151–200	0	0
201–203	1	2.13
19–203	**47**	**100**

Table 21. Kisnytsia: number and percentage of buildings at the settlement grouped by area in steps of 50 m².

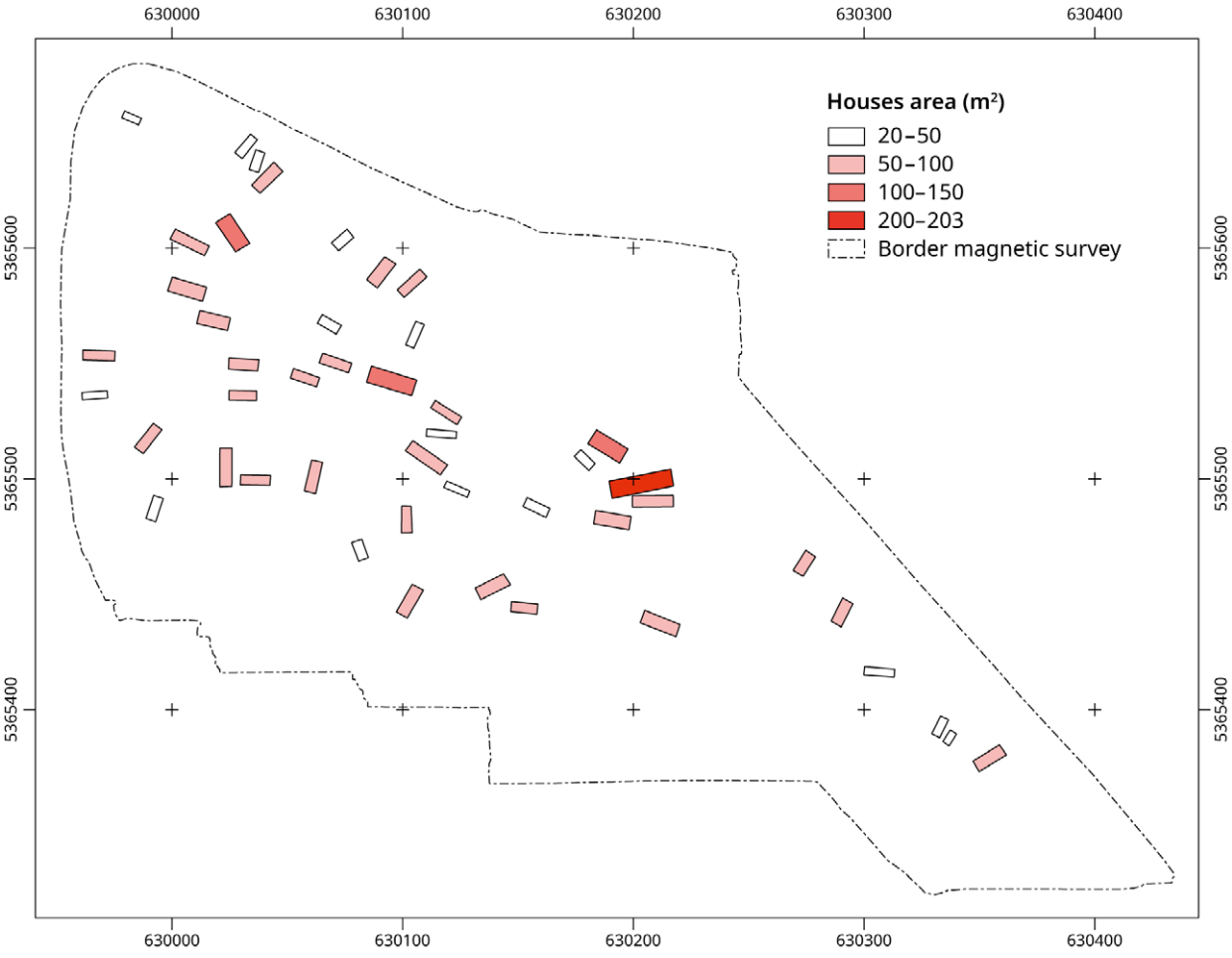


Figure 110. Kisnytsia: location of the houses categorised by their floor size.

between them, which is visible in the western part of the settlement. This part of the site may existed during Trypillia C1 stage and other parts during Trypillia C2 stage (Rud *et al.* 2023). The central part of the settlement seems to be built chaotically at first sight; however, there is a system in the location of the buildings around the space which is free of buildings. The general number of features in the central zone are anomalies of pits. At some distance from the central zone is the line of buildings in the eastern part of the settlement. The largest building in the settlement, which is located in the north-eastern part of the central zone, is the best candidate for the role of the mega-structure.

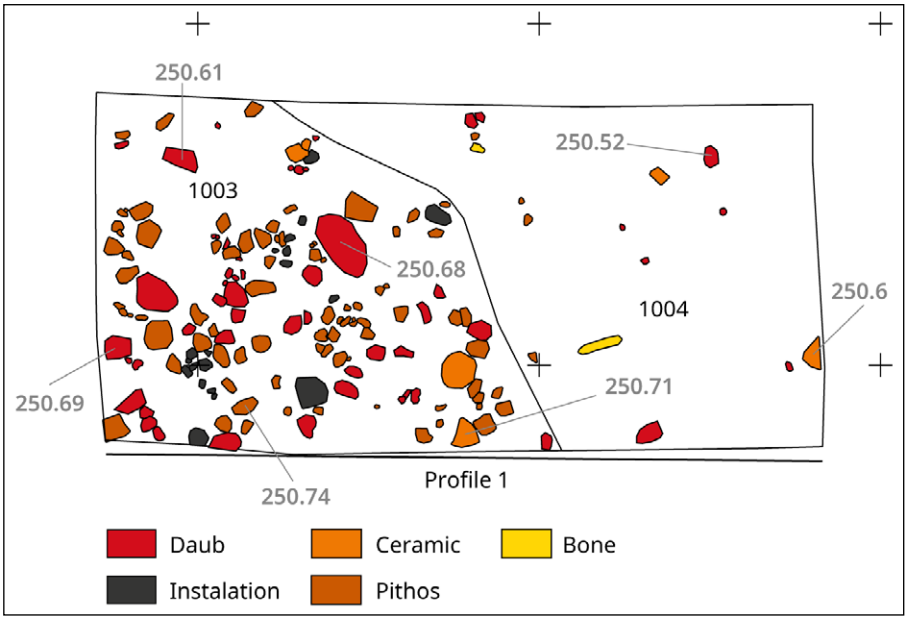


Figure 111. Kisnytsia: Planum 1 displaying the position of artefacts within Features 1003 and 1004.

Excavation

Trench 1, pit

Test Trench 1 with an area of 1 × 2 m was located in order to examine the eastern part of the oval anomaly 4.5 x 2.8 m in size (Fig. 108). The maximum magnetic flux density value of the anomaly is no more than 5 nT. The anomaly is found 4.3 m to the north of the anomaly of the building. The latter is 8.8 x 4.6 m in size and oriented in a north-east/south-west direction. The building is a part of a line of buildings in the northern part of the western zone.

In the western part of the test trench, in Layer 1003, 42–49 cm below the modern surface, a cluster of two types of burnt clay fragments was found (Fig. 111). The first type is identified as pieces of daub from wooden-clay buildings, since they are made of mixtures of clay with chaff. Sometimes these fragments have imprints of wooden constructions (twigs, split wood). The maximum size of the fragments is 15 cm. The second type is fragments of burnt clay with no visible plant admixtures, and which have one flat surface. They are the fragments of clay installation 1.5–2 cm in thickness. The fragments of both types are located chaotically. The fragments of walls of pithos, which are spread all over Feature 1003, have a similar thickness as the fragments of installation. The walls of the pithos are smoothed on both sides; the pithos is made of poorly mixed iron-bearing clay. Several fragments of pottery and a ceramic spindle whorl were also found in Feature 1003.

Layer 1004+1005 is located below the daub cluster. Here several fragments of pottery were found, as well as animal bones. The ceramic loom weight was also found here. The bottom of Layer 1004 and 1005 is not flat; it slightly deepens in the western part of the test trench. Below the feature the natural layer (1006) is located and consist of yellow sandy clay, grey-yellow sand and grey limestone.

The soil within Layers 1003, 1004+1005, as well as 1002, which is located above the daub cluster, is brown with a greyish shade (Figs. 112, 113). Above Feature 1002 is the Chernozem (1001) layer, 29–30 cm thick.

Considering the homogeneous character of the Layers 1002–1005, the total thickness of which is 74 cm in the western part of the test trench and 45 cm in the eastern part, we assume that they are the filling of a shallow pit with a sloping bottom. If the centre of the pit is in the western part of the test trench, judging by

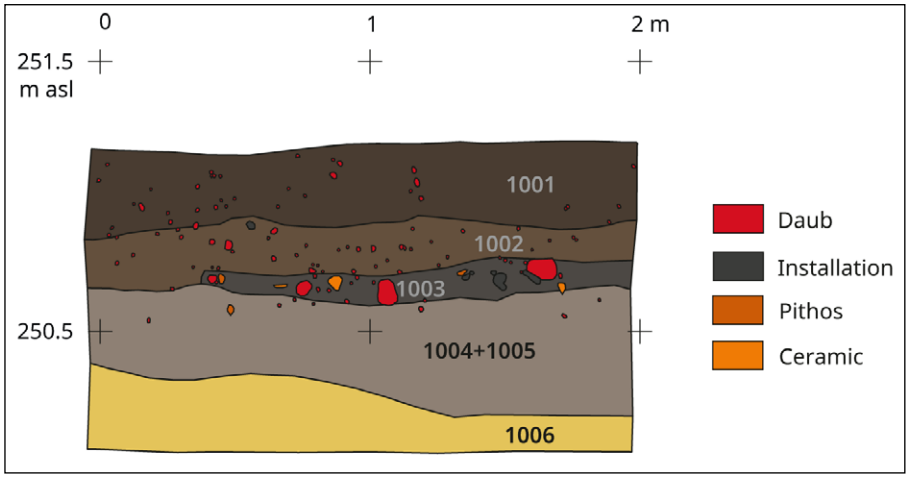


Figure 112. Kisnytsia, Profile 1: 1001 – Chernozem; 1002, 1003, 1004, 1005 – brown, greyish; 1006 – multicoloured (yellow clay, grey-yellow sand, grey limestone).



Figure 113. Kisnytsia: photo displaying the stratigraphy of Profile 1.

the anomaly's configuration, the edge of the pit in the eastern part of the test trench has not been reached. It appears that the anomaly which is visible on the magnetic map is created mostly by the artefacts from Layer 1003. These artefacts should be considered as domestic waste. Architectural details are found in the filling of the pit.

^{14}C dating

From cattle bones recovered from Trench 1, three ^{14}C dates Poz-109380, Poz-109381 and Poz-109382 were obtained (Suppl. 1 in Chapter 19, this work, Vol. II). These samples were taken from two successive layers of the pit fill. Due to the inconsistent date of Poz-109381, a Bayesian model using all three dates gives very low likelihoods of only A_{model}=22.6 and $A_{overall}$=23.5. Higher probabilities are obtained by excluding this date. By doing this, the filling of the pit took place with the highest probability between 3640 and 3450 BCE (Tab. 22; Fig. 114).

	Dating range 68.3%	Dating range 95.4%	Median	Highest dating probability
Boundary start lower filling	3703–3529	4206–416	3635	3640 or 3570 or 3550
Duration	0–193	0–681	117	30 or 50 or 120
Boundary lower-upper filling	3570–3464	3625–2406	3519	3520
Duration	0–198	0–738	119	30 or 70
Boundary end upper filling	3514–3313	3610–2386	3390	3490 or 3450

Table 22. Kisnytsia: Bayesian model of the backfilling process of the pit investigated in Trench 1, excluding the date Poz-109381. A_{model}=101.4; $A_{overall}$=101.3. All boundary dates in BCE, durations in years.

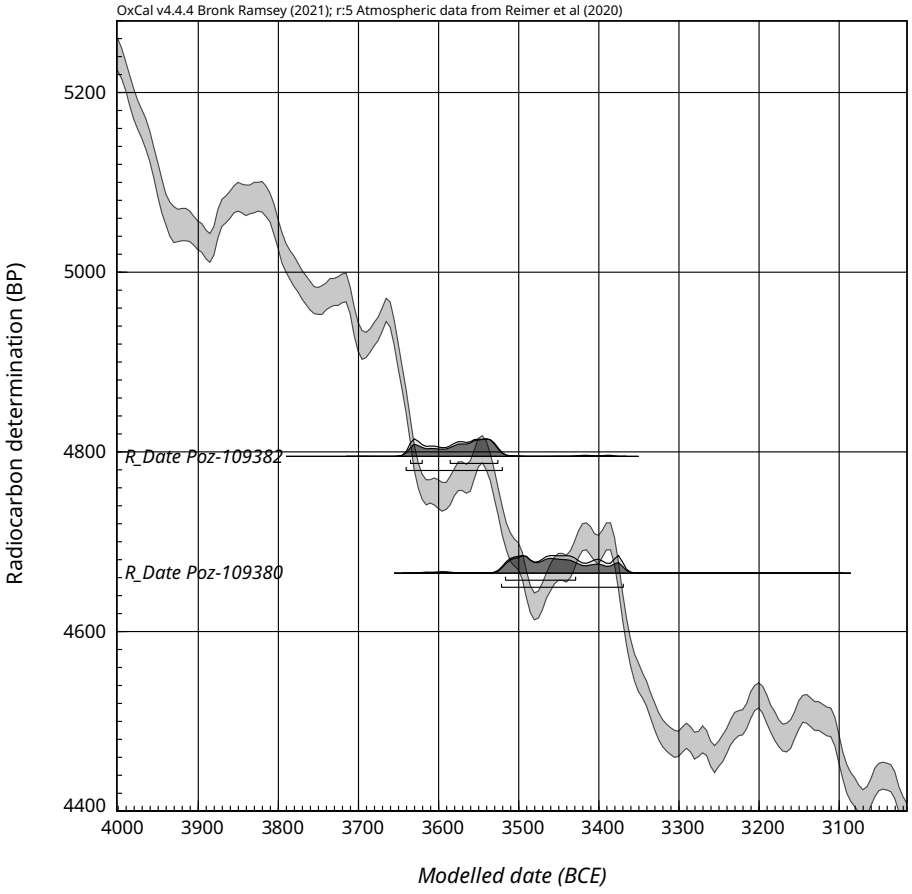


Figure 114. Kisnytsia: curve plot of three modelled ^{14}C dates from the pit in Trench 1.

Hariachkivka 2

Research history

The site was initially discovered during fieldwalking by V. T. Zahoruiko in 1993 (Zahoruiko 1993, 2, Fig. 3, Fig. 12: 5–11, Fig. 24; Lototska and Ocheretnyi 1997). SPAE examined the location of the site in May 2015 (Rud *et al.* 2016). Surface artefacts were collected and the area of distribution was clarified. In spring 2017 the magnetic scanning of the site was conducted in cooperation between CAU and IA NASU.

Geographical position

The site Hariachkivka 2 (48°17’47.6”N, 28°42’48.6”E) is located 2.6 km to the south-west of Hariachkivka village (Horodkivka territorial commnity of the Tulchyn Raion), on the right bank of the Hariachkivka River (Hariachkivka → Vilshanka



Figure 115. Hariachkivka 2: view of the location of the site and the valley of the Hariachkivka River. Photo taken from the north-east in May 2015.

→ Markivka → Dniester; Fig. 115). The surface artefacts are spread over the slope of the plateau 15–17 m above the water level in the river. The slope of the earth's surface within the settlement has a south-east exposition.

Fieldwalking and magnetic survey

During the survey in 2015 the surface artefacts were collected over an area of approximately 100 × 100 m. Most of the surface collection was found on the ploughed part of the site. It is also present on the grass-covered area in the south-east part of the site. It is important to say that during the surface investigation all over the site territory no fragments of burnt clay (daub) were found, only fragments of vessels which belong to the Gordyneshti group of the Trypillia C2 period (Rud *et al.* 2019b, 20–21, Fig. 14).

The surface investigation of the site in 2017 confirmed the previous results – the absence of daub fragments, which we usually find during fieldwalking at the Trypillia settlements. As mentioned above, on the site territory fragments of ceramics vessels up to 15 cm in size were found, as well as a fragment of an axe blade, which was made of stone. This time the distribution of the surface artefacts was documented via GPS equipment (Fig. 116). The artefacts were found only on the territory of the ploughed field, over an area of 0.2 ha.

The magnetic survey was conducted over an area of 1.3 ha. It covered the whole area of the artefacts distribution, as well as the area around it. However, anomalies which could indicate archaeological features were not found on the scanned territory. It is possible that we are dealing with a short-term camp, forming a cultural layer which is not associated with any permanent features.

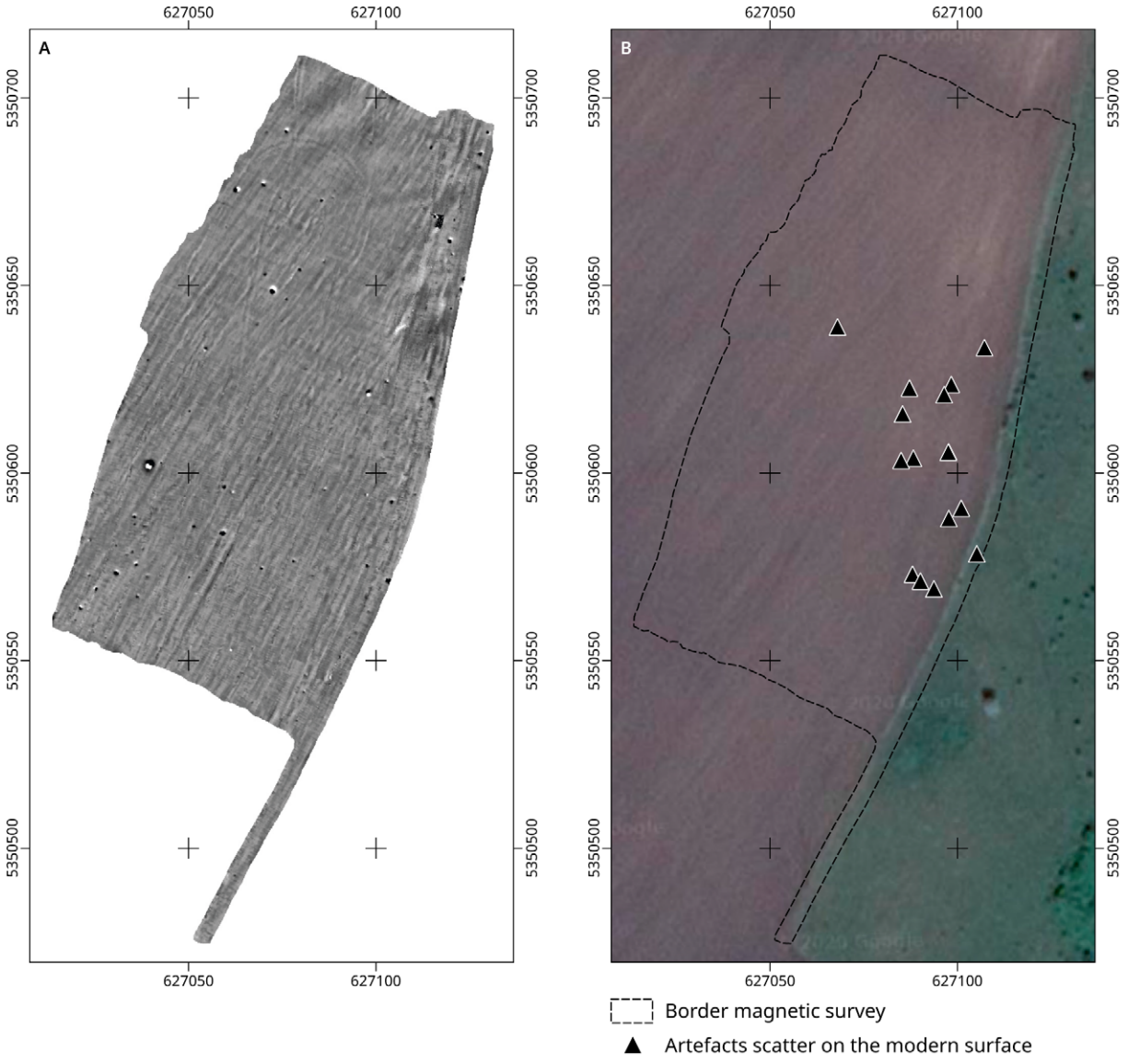


Figure 116. Hariachkivka 2: magnetic plan (A) and the artefacts distribution (B) on the Google satellite image.

Discussion

Although we cannot address all aspects of the investigated settlements in this chapter, we would like to summarise and discuss the most important results of our investigations in the Kryzhopil region.

Chronology

Chronologically, the majority of the investigated settlements fall into two periods. The oldest dates originate from the settlement Hariachkivka 8, where settlement activities are possible already around or after 4300 BCE. The other investigated settlements were founded at the earliest shortly before 4200 BCE and existed until around 4000 BCE. Due to the plateau-like structure of the calibration curve in this period, the dating intervals might be over-long and mask shorter occupations.

Although there is also evidence in Kisnytsia of settlement activities during the period Trypillia C2, there seems to be a sharp overall decrease in settlement intensity in the region between about 4000 and 3600 BCE. We can demonstrate

that this decrease is not the result of a subjective selection of sites, but in fact is representative for the settlement history of the region, by systematic surface collections in the region (Rud *et al.* in prep.). This hiatus coincides with the phase of aggregated settlements and mega-sites in other areas, such as the region around Chechelnyk located slightly to the south-east, the Syniukha River basin and the Prut basin in the territory of present-day north-west Moldova.

Settlement layouts

The investigated settlements of the period Trypillia B1–B2 (ca. 4300–3950 BCE) show concentric settlement layouts, whose basic planning component is a circular ring-corridor (cf. Chapter 20, this work, Vol. II). This principle of spatial organisation of settlements was applied also in middle Trypillia settlements, including the largest mega-sites in the catchment areas of the Southern Bug and the Syniukha. Elsewhere it has been suggested that the concentric settlement layouts ensured equal access to the structural elements and infrastructure of the settlements (*e.g.* ring-corridor, central unbuilt space) and have analogies to floor plans of egalitarian organised communities from cross-cultural ethnographic contexts (*e.g.* Wagner 2019). In this respect, this type of settlement supports the idea that founders of settlements shared an ideology oriented towards social equality, which manifests itself, among other things, in temporarily decreasing differences in house sizes (Hofmann *et al.* 2024).

The ring-shaped settlements of the Kryzhopil region represent the earliest dated evidence of this settlement type to date. This again raises the question of where this form of settlement organisation was first developed. The earlier dating of ring-shaped settlement ground plans in the Kryzhopil region compared to the Syniukha River catchment supports the idea of the spread of this settlement type from west to east in the context of the gradual colonisation of the NW-Pontic forest steppe region together with other elements of the 'Trypillia package' such as painted pottery and mega-structures (Țerna *et al.* 2018). In addition, the radial arrangement of houses in the zone outside the ring corridor, which elsewhere occurs in later settlements in the Prut-Dniester interflow area such as Petreni (Rassmann *et al.* 2016; Uhl *et al.* 2017), Stolniceni 1 (Țerna *et al.* 2019) and Trinca (Chapter 17, this work, Vol. II), indicates connections in a westerly direction (Chapter 20, this work, Vol. II). However, evidence of even earlier or simultaneous settlements of this type in the Prut catchment area by ^{14}C dating is still lacking.

The two Trypillia C2-period settlements of Krynychky-Ferma and Kisnytsia have layouts in which the 'classic' Trypillia settlement structure is only rudimentarily apparent and a circumferential ring-corridor no longer exists as a basic planning element. In the case of Krynychky-Ferma, similarly to Apolianka in the Syniukha region (cf. Rassmann *et al.* 2014; Ohlrau 2015; Chapter 13, this work, Vol. I), there are several smaller groups of houses separated from each other. The settlement of Kisnytsia consists of two to three clusters of houses directly adjacent to each other within which there is a relatively disorderly arrangement of houses. Comparable so-called degraded layouts from the disintegration phase of aggregated Trypillia settlements have also been detected in different parts of the Trypillia network (Chapter 20, this work, Vol. II).

Communal buildings

In the Trypillia B1–B2 settlements of Zabolotne, Ternivka, Vilshanka, Hariachkivka 3 and Hariachkivka 7, buildings were interpreted as so-called mega-structures or integrative communal buildings, on the basis of three main criteria elaborated elsewhere (Hofmann *et al.* 2019b). The main criterion for their identification is the spatially separated, highly visible positioning of the buildings in the public space of

the settlements. Secondary criteria are the size and the architecture deviating from residential buildings.

In the investigated settlements of the Kryzhopil region, mega-structures are usually located in the north-east area of the settlements in the inner row of buildings of the ring corridor, but are usually somewhat separated there. Moreover, frequently they are additionally characterised by being of an extraordinarily size. Similar buildings also existed in the settlement of Hariachkivka 8, where, however, they are located in the north-west and therefore their identification is ambiguous. Similarly, the character of several oversized buildings in the Late-Trypillia settlement of Kisnytsia is not clearly identifiable, due to its disordered settlement layout.

In addition to similar 'high-level' mega-structures for entire settlements, numerous smaller mega-structures have been identified in settlements of the Syniukha Region. Usually they are located in the public space and on the periphery of larger settlements and mega-sites and are interpreted as 'low-level' integrative institutions of certain parts of the community (*e.g.* quarters, neighbourhoods). This category of communal buildings has not yet been found in settlements in the Kryzhopil region. Several explanations are possible: (1) the lack of low-level integrative buildings could be due to the comparatively small population sizes of the communities with a maximum settlement size of 40 ha (see next section); (2) evidence for low-level mega-structures in the period before 4000 BCE is very uncertain in other regions. It could therefore also be that the political system underlying these built structures was not yet fully developed; (3) with the exception of the settlement of Petreni, low-level mega-structures are lacking in the area to the west of the region (present-day Moldova). Their absence from the Kryzhopil region could therefore also be due to regional differences in social organisation; (4) in the settlement of Stolniceni 1, evidence was found for the assumption (Chapter 16, this work, Vol. II) that so-called alpha buildings integrated into blocks of buildings may also have a communal purpose. Accordingly, we cannot exclude the possibility that communal low-level integrative buildings cannot be easily distinguished from normal dwellings.

Twin settlements

An aspect which has hardly been investigated in Trypillia contexts so far are so-called 'double/triple' or 'binary' settlements in which, as in the settlement complexes of Zabolotne-Ternivka-Soniachne and Hariachkivka 7 and 8, multiple settlements existed next to each other in close vicinity. According to the ^{14}C dating available to us, these settlements were contemporaneous, although we cannot completely exclude a non-simultaneity because of the structure of the calibration curve between 4200 and 4000 BCE. Stanislav Țerna and Andreea Vornicu-Țerna have recently drawn attention to comparable settlement complexes in the Prut-Dniester region (Țerna and Vornicu-Țerna 2021). Similar phenomena exist, for example, in different parts of the Pannonian Plain during the Neolithic (Kalafatić and Šiljeg 2018; Hofmann *et al.* 2019a; Furholt *et al.* 2020). Three spatially separated settlement cores of Vrable are interpreted as neighbourhoods within a community, which maintained a certain political and economic autonomy over a longer period and between which tensions existed. Against the background of the idea that large aggregated Trypillia settlements and mega-sites are the result of the fusion of previously independent smaller communities (*e.g.* Ohlrau 2020a; Hofmann *et al.* 2019b), double or triple settlements could be interpreted as early stages of such fusions. The early dating of the settlements in the Kryzhopil region at the beginning of the Trypillia aggregation process seems to support such a scenario. However, in contrast, the evidence dates to the period between 3950 and 3700 BCE (Țerna and Vornicu-Țerna 2021) and thus at the peak of Trypillia population aggregation or the period after. Taking into

consideration that in the Prut-Dniester interflow settlements larger than 30 ha have never been found, this comparatively late dating could indicate that a fusion of several communities into planned built units, which led in the Syniukha area to the emergence of mega-sites, did not occur here. However, further targeted investigation of such settlements is needed before such far-reaching conclusions can be drawn.

Demography

The settlement plans presented here provide important new data for estimates of population sizes of Trypillia settlements. By providing detailed high-resolution data on the size and number of houses of smaller and larger sites from the beginning of the sequence of aggregated Trypillia settlements, this can potentially contribute substantially to the modelling of Trypillia mega-site formation processes. They also provide further data from the phase that followed the disintegration of large aggregated Trypillia settlements.

The investigated settlements represent communities of different sizes. While Ternivka, Hariachkivka 3 and Hariachkivka 7 are small settlements from the early phase of Trypillia population aggregation, Hariachkivka 8, Vilshanka and especially Zabolotne may already represent the result of population concentration. Krynychky-Ferma and Kisnytsia are examples of settlements from the post-aggregation phase. The site of Hariachkivka 2, where no building structures can be detected archaeomagnetically, seems to be a settlement site that was used for a short time only, indicating the possibility of increased mobility in settlement behaviour.

The approximation of local group sizes in the studied settlements presented below is based on the methodology for estimating local population sizes recently described by René Ohlrau (2020b) for Trypillia mega-sites of the Syniukha area. This is based on the one hand on cross-culturally obtained data on household sizes according to Sherburne F. Cook (1972) and Oleksandr Diachenko (2016) and on the other hand on cross-culturally based data on the floor area per person requirement according to Marco Porčić (2010; 2012). It must be taken into account that such estimates do have enormous error ranges. In addition, there is the problem of quantifying the number of simultaneously inhabited houses, which can currently only be partly solved by large dating series. In our study, this is further complicated by the fact that the structure of the ^{14}C calibration curve in the time interval between 4200 and 3950 BCE possibly leads to overlong dating ranges. We therefore assume two different scenarios in our calculations: 1) the settlements existed for a shorter period than suggested by the ^{14}C dating – in this case, we assume two house generations of 50 years each; 2) the settlements existed over a span of four house generations of 50 years, which essentially corresponds to the highest dating probabilities (Tab. 23, columns 8 and 9).

Based on average household sizes (4–7 persons/household), the total populations (entire life span!) of the investigated settlements of the Kryzhopil region of smaller settlements of the period Trypillia B1–B2 range between 300 and 700 persons (Tab. 23, columns 10 and 11). For settlements of the period Trypillia C2 the value varies between 175 and 350 inhabitants. Depending on whether one assumes durations of two or four generations of 50 years, 'living' populations of small settlements range between 150 and 350 individuals for the Trypillia B1–B2 period and between 100 and 175 individuals for the Trypillia C2 period (Tab. 23, columns 19 and 20). The calculated total populations of large settlements of the period Trypillia B1–B2 vary between 540 and 3675 individuals, those of the simultaneously inhabiting population in the range between 270 and 1838 individuals.

With the approach based on house sizes, the total population of small settlements from the period Trypillia B1–B2 (entire period!) ranges between 135 and 425 persons, those of larger settlements between 465 and 2518, (based on a value of 6 m^2/person; Tab. 23, column 17). The total populations of Trypillia C2 period settlements range

	Settlement size & houses						Dating		Calculation based on household size				Calculation based on floor area						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	**17**	18	19	20
site	measured area	total settlement size (ha)	number of houses (measured area)	number of houses (extrapolated)	houses/ha	median house size (m^2)	dating (highest probability)	duration (highest probability)	minimal total population (household size 4 persons)	maximum total population (household size 7 persons)	**population household size (4p/household + 2 house generations**	**population household size (7p/household + 2 house generations**	total floor area (measured area)	total floor area (extrapolated)	Minimum total population (floor area 11.82 m^2/p/3)	**median total population (floor area 6 m^2/p/3)**	maximum total population (floor area 1.18 m^2/p/3)	**population floor area min (6 m^2/p + 4 house generations)**	**population floor area max (6 m^2/p + 2 house generations)**
Zabolotne	30	40	394	525	13.1	81.2	4230-4020	210	2100	3675	**1050**	**1838**	33989	45319	1278	**2518**	12802	**629**	**1259**
Ternivka	5.5	7	58	74	10.5	74.1	4220-3990	230	296	518	**148**	**259**	4159	5294	149	**294**	1495	**74**	**147**
Soniachne	2.1	?	2		1														
Krynychky-Ferma	8	14	25	44	3.1	98.2	3620-3530	90	176	308	**88**	**154**	2234	3909	110	**217**	1104	**54**	**109**
Vilshanka	18.9	25	108	143	5.7	46.6	4220-4040	180	572	1001	**286**	**501**	5764	7624	215	**424**	2154	**106**	**212**
Hariachkivka 2	1.3	1.3	0	0															
Kisnytsia	6.5	6.5	49	49	7.5	63.2	3640-3450	190	196	343	**98**	**172**	4717	4717	133	**262**	1332	**66**	**131**
Hariachkivka 3	3.3	7	46	98	13.9	72.6	4025-3960	60	392	686	**196**	**343**	3476	7372	208	**410**	2083	**102**	**205**
Hariachkivka 7	3.8	5.5	29	80	7.6	51.5	4235-4050	185	320	560	**160**	**280**	1672	2420	68	**134**	684	**34**	**67**
Hariachkivka 8	7.5	7.5	135	135	18	76	4225-4040	185	540	945	**270**	**473**	10172	10172	287	**565**	2874	**141**	**283**

Table 23. Compilation of settlement sizes, number of houses, mean house sizes, dating and estimated populations of the investigated settlements of the Kryzhopil region.

between 217 and 262 inhabitants. Depending on whether these are distributed over two or four successive house generations, the populations living at the same time in small settlements of the Trypillia B1–B2 period were between 35–200 persons. Settlements of the Trypillia C2 period tended to be even smaller, with populations of 50–130 people. In contrast, large communities such as Zabolotne have population sizes in the range between 600 and 1250 persons.

Conclusions

Based on extensive geophysical and archaeological fieldwork at ten Trypillia settlements in the region around the town of Kryzhopil, we can show that intensive settlement activity took place here between 4300 and 4000 BCE and again between 3650 and 3450 BCE. Six of these settlements from the period between 4300 and 4000 BCE were organised according to a novel ring-shaped principle along a circumferential ring corridor, which was applied after 4000 BCE in a slightly modified form at much larger mega-sites. Details of the ground plans indicate western relations; however possible predecessors have not yet been dated here. Settlements of the phase after 3650 BCE, on the other hand, show layouts that only reveal rudiments of this ring-shaped principle and are otherwise organised in smaller groups of houses. By their position and size, communal buildings can be identified in the settlements of the first phase of intensive settlement activity, which presumably represented institutions for integrative activities and decision-making processes at the level of the settlement as a whole. According to reconstructions of population sizes, most of them were relatively small communities with 35–200 inhabitants (4300–4000 BCE) or 50–130 inhabitants (3650–3450 BCE). On the other hand, some settlements with larger populations show that the processes of population aggregation, which led to the formation of huge mega-sites in neighbouring regions somewhat later, was already fully underway in the period between 4300 and 4000 BCE. According to the available data, habitation in the Kryzhopil region ended shortly after 4000 BCE, just at the time when huge mega-sites were founded in the Syniukha River catchment area (Shatilo 2021) and in the basin of the Southern Bug (Rud *et al.* 2019a). To us it seems highly plausible that people from the Kryzhopil region migrated to the left bank of the Southern Bug River (Hofmann and Shatilo 2022) and even further – right to the Dnipro area near modern Kyiv (Videiko *et al.* 2021). Thus, the re-occupation of the region took place only after the end of the Trypillia aggregation phase. However, this hypothesis still needs further substantiation by the presentation of the find materials from our excavations and systematic surface collections (Rud *et al.* in prep.).

Acknowledgements

This study was funded by the DFG Collaborative Research Centre CRC1266 ‘Scales of Transformation – Human-Environmental Interaction in Prehistoric and Archaic Societies’ (German Research Foundation – Project number 290391021 – SFB1266). The authors express their deepest appreciation to all those who participated in the joint research in the region around the town of Kryzhopil. Archaeologist and restorer Stanislav Fedorov, student of Kiel University Gesa Salefski, PhD student of Borys Grinhenko Kyiv University Yevhenii Sliesariev, student of Vinnytsia State Pedagogical University Yuliia Melnychuk and student of National University of Kyiv-Mohyla Academy Danylo Klochko took the most active part in the fieldwork. Local historian Borys Vitsa helped with the localisation of the settlements around Kryzhopil. We would like to express special appreciation to the dean of the Faculty of History, Ethnology and Law of the Vinnytsia State Pedagogical University Yurii Zinko, and to

the head of archaeological practice Valentyna Hrebeniova, as well as to all the students of that same faculty who helped during the excavations at the settlements around the village of Hariachkivka. The authors are deeply indebted to Mykhailo Potupchyk, head of the Cultural Heritage Protection sector of the Department of Culture and Arts of the Vinnytsia Regional State Administration, who provided invaluable assistance in organising and conducting the fieldwork. Our fieldwork would not have been possible without the support and understanding of local community leaders and farmers. Thus, we express our deepest gratitude to Volodymyr Vasylyshen, the head of a farm enterprise in Kryzhopil. We are very thankful to Oleh Kotiuzhanskyi, the head of the Hariachkivka rural council for the hospitality shown to the participants of the expedition during the summer campaign of 2019.

References

Bronk Ramsey, C., 2009. Bayesian Analysis of Radiocarbon Dates. *Radiocarbon*, 51 (1), 337–360. Available from: DOI:10.1017/S0033822200033865

Burdo, N. and Videiko, M., 2016. Nebelivka: From Magnetic Prospection to New Features of Mega-Sites. *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE.* Themes in Contemporary Archaeology 2. London, New York: Routledge, 95–116. Available from: DOI:10.4324/9781315630731

Chapman, J., Videiko, M.Y., Hale, D., Gaydarska, B., Burdo, N., Rassmann, K., Mischka, C., Müller, J., Korvin-Piotrovskiy, A. and Kruts, V., 2014. The Second Phase of the Trypillia Mega-Site Methodological Revolution: A New Research Agenda. *European Journal of Archaeology*, 17 (3), 369–406. Available from: DOI:10.1179/1461957114Y.0000000062

Chernovol, D., 2014. The Tripolye BI Dwellings in the Middle Dniester Region. *In*: G. Dumitroaia, C. Preoteasa and C.-D. Nicola, eds. *Cucuteni Culture within the European Neo-Eneolithic Context. International Colloquium Cucuteni – 130: abstracts: Piatra-Neamț, 15th - 17th October 2014*. Piatra-Neamț: Editura "Constantin Matasă", 108–109.

Chernovol 2019: Черновол, Д., 2019. Інтер›єр споруд Трипільскої культьури. Автореферат дисертації на здобуття наукового ступеня кандидата історичних наук. [Summary of the unpublished PhD thesis. Національна академія наук України].

Cook, S.F., 1972. *Prehistoric Demography*. McCaleb Module in Anthropology 1. Reading/Massachusetts: Addison-Wesley.

Dedov 2002: Дєдов, О.В., 2002. Ґрунтовий покрив. *In*: Г.І. Денисика, ed. *Середнє Побужжя*. Вінниця: Гіпаніс, 82–87.

Denysyk 1998: Денисик, Г.І., 1998. *Природнича географія Поділля*. Вінниця: Еко Бізнес Центр.

Diachenko, A., 2016. Demography Reloaded. *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE*. Themes in Contemporary Archaeology 2. London, New York: Routledge, 181–193. Available from: DOI:10.4324/9781315630731

Furholt, M., Müller-Scheeßel, N., Wunderlich, M., Cheben, I. and Müller, J., 2020. Communality and Discord in an Early Neolithic Settlement Agglomeration: The LBK Site of Vráble, Southwest Slovakia. *Cambridge Archaeological Journal*, 30 (3), 469–489. Available from: DOI:10.1017/S0959774320000049

Hofmann, R. and Shatilo, L., 2022. Tripolye population aggregation and dispersal in light of regional settlement trajectories. *In*: M. Dębiec, J. Gorski, J. Müller, M. Nowak, A. Pelisiak, T. Saile and P. Włodarczak, eds. *From Farmers to Heroes? Archaeological Studies in Honor of Sławomir Kadrow*. Universitätsforschungen zur prähistorischen Archäologie 376. Bonn: Dr. Rudolf Habelt, 197–212.

Hofmann, R., Țerna, S., Ursu, C.-E., Brandtstätter, L., Tiede, H., Mainusch, W. and Authenrieth, S., 2016. Spatial organization and population size of small Cu-

cuteni-Tripolye settlements: Results of geomagnetic surveys in Baia and Adâncata, Suceava County, Bucovina, Eastern Romania. *Journal of Neolithic Archaeology*, 18, 157–189. Available from: DOI:10.12766/jna.2016.4

Hofmann, R., Shatilo, M., Ohlrau, R., Dal Corso, M., Dreibrodt, S., Videiko, M., Rassmann, K., Kirleis, W. and Müller, J., 2018. Tripolye – Strategy and Results of an ongoing Ukrainian-European Project. *Vita Antiqua*, 10, 146–154. Available from: DOI:10.37098/2519-4542-2018-1-10-146-154.

Hofmann, R., Medović, A., Furholt, M., Medović, I., Stanković-Pešterac, T., Dreibrodt, S., Martini, S. and Hofmann, A., 2019a. Late Neolithic multicomponent sites of the Tisza region and the emergence of centripetal settlement layouts. *Praehistorische Zeitschrift*, 94 (2), 351–378. Available from: DOI:10.1515/pz-2019-0003

Hofmann, R., Müller, J., Shatilo, L., Videiko, M., Ohlrau, R., Rud, V., Burdo, N., Dal Corso, M., Dreibrodt, S. and Kirleis, W., 2019b. Governing Tripolye: Integrative architecture in Tripolye settlements. *PLoS ONE*, 14 (9), e0222243. Available from: DOI:10.1371/journal.pone.0222243

Hofmann, R., Müller-Scheeßel, N. and Müller, J., 2024. Trypillia mega-sites: a social levelling concept? Antiquity, 98 (398), 380–400. Available from: DOI:10.15184/aqy.2024.18

Hoshko *et al.* 2020: Гошко, Т., Рудь, В. and Хофманн, Р., 2020. Нові знахідки мідних виробів трипільської культури з басейнів Дністра та Південного Бугу. *Київські історичні студії: науковий журнал*, 2 (11), 81–85. Available from: DOI:10.28925/2524-0757.2020.2.11

Husiev 1995: Гусєв, С.О., 1995. *Трипільська культура Середнього Побужжя рубежу IV–III тис. до н. е.* Вінниця: Антекс–УЛТД.

Kalafatić, H. and Šiljeg, B., 2018. Krugovi Parnjaci: novi uvidi u neolitičke obrasce naseljavanja / Twin circles: new insights in the Neolithic settlement pattern. *Prilozi Instituta za arheologiju u Zagrebu,* 35, 71–111. Available from: DOI:10.33254/piaz.35.3

Kirleis, W., Dal Corso, M., Pashkevych, G., Schlütz, F., Hofmann, R., Terna, A., Dreibrodt, S., Rud, V., Videiko, M.Y. and Müller, J., 2024. A complex subsistence regime revealed for Cucuteni–Trypillia sites in Chalcolithic eastern Europe based on new and old macrobotanical data. *Vegetation History and Archaeobotany*, 33, 75–90. Available from: DOI:10.1007/s00334-023-00936-y

Korvin-Piotrovskiy, A., Hofmann, R., Rassmann, K., Videiko, M.Y. and Brandtstätter, L., 2016. Pottery Kilns in Trypillian Settlements. Tracing the Division of Labour and the Social Organization of Copper Age Communities. *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE*. Themes in Contemporary Archaeology 2. London, New York: Routledge, 221–252. Available from: DOI:10.4324/9781315630731

Kruts, V.A., Korvin-Piotrovskiy, A.G., Rassmann, K. and Peters, D., 2011. Talianki: reloaded. Geomagnetic Prospection three decades after V.P. Dutkin's work. *In*: Круц, В.А., Корвин-Пиотровский, А.Г., Рыжов, С.Н., Черновол, Д.К. and Чабанюк, eds. Трипольское поселение-гигант Тальянки. Исследования 2011 г / *Talianki – Settlement-Giant of the Tripolian Culture. Investigations in 2011*. Киев: Институт археологии НАН Украины, 60–85.

Levada1996: Левада, М.Є., 1996. *Звіт про проведення суцільних пам'яткоохоронних досліджень (археологічних розвідок) траси з'єднувального нафтопроводу НПК «Південний» – Західна Україна в 1996 році*. Київ: Науковий архів Інституту археології НАН України. [Unpublished report in the archive of the Institute for Archaeology of the National Academy of Science of Ukraine (IA НАНУ), archive signature: 1996/21].

Lototska and Ocheretnyi 1997: Лотоцька, В.Т. and Очеретний, В.В., 1997. Археологічна розвідка Подільської археологічної експедиції. *Археологічні дослідження в Україні*, 1993, 79–80.

Müller, J. and Videiko, M., 2016. Maidanetske: New Facts of a Mega-Site *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE*. Themes in Contemporary Archaeology 2. London, New York: Routledge, 71–93. Available from: DOI:10.4324/9781315630731

Ohlrau, R., 2015. Trypillia Großsiedlungen: Geomagnetische Prospektion und architektursoziologische Perspektiven. *Journal of Neolithic Archaeology*, 17, 17–100. Available from: DOI:10.12766/jna.2015.3

Ohlrau, R., 2020a. *Maidanets'ke: Development and decline of a Trypillia mega-site in Central Ukraine*. Scales of Transformation in Prehistoric and Archaic Societies 7. Leiden: Sidestone Press. Available from: DOI:10.59641/h0912kt

Ohlrau, R., 2020b. Modelling Trypillia 'mega-site' populations. *In*: M. Dębiec and T. Saile, eds. *A Planitiebus usque ad montes: Studia Archaeologica Andreae Pelisiak vitae anno sexagesimo quinto oblata*. Rzeszów: Zimowit, 399–413.

Porčić, M., 2010. House Floor Area as a Correlate of Marital Residence Pattern: A Logistic Regression Approach. *Cross-Cultural Research*, 44 (4), 405–424. Available from: DOI:10.1177/1069397110378839

Porčić, M., 2012. Contextual analysis of fragmentation of the anthropomorphic figurines from the Late Neolithic site of Selevac. *Etnoantropološki problemi / Issues in Ethnology and Anthropology,* 7 (3), 809–827. Available from: DOI:10.21301/EAP.v7i3.11

Potupchyk 2003: Потупчик, М.В., 2003. *Археологічні пам'ятки Крижопільського району (розвідка 2003 р)*. Вінниця. [Unpublished manuscript, archived in the Department of culture and tourism of the Kryzhopil regional council].

Potupchyk *et al.* 1996: Потупчик, М.В., Левада, М.Є. and Потупчик, М.Є., 1996. *Звіт про археологічну розвідку у Вінницькій області в 1996 р*. Київ: Науковий архів Інституту археології НАН України. [Unpublished report in the archive of the Institute for Archaeology of the National Academy of Science of Ukraine (IA НАНУ), archive signature: 1996/88].

Rassmann, K., Ohlrau, R., Hofmann, R., Mischka, C., Burdo, N., Videjko, M.Y. and Müller, J., 2014. High precision Tripolye settlement plans, demographic estimations and settlement organization. *Journal of Neolithic Archaeology*, 16, 96–134. Available from: DOI:10.12766/jna.2014.3

Rassmann, K., Mertl, P., Voss, H.-U., Bicbaev, V., Popa, A. and Musteață, S., 2016. Copper Age settlements in Moldova: Insights into a Complex Phenomenon from Recent Geomagnetic Surveys. *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE*. Themes in Contemporary Archaeology 2. London, New York: Routledge, 55–70. Available from: DOI:10.4324/9781315630731

Reimer, P.J., Austin, W.E.N., Bard, E., Bayliss, A., Blackwell, P.G., Bronk Ramsey, C., Butzin, M., Cheng, H., Edwards, R.L., Friedrich, M., Grootes, P.M., Guilderson, T.P., Hajdas, I., Heaton, T.J., Hogg, A.G., Hughen, K.A., Kromer, B., Manning, S.W., Muscheler, R., Palmer, J.G., Pearson, C., van der Plicht, J., Reimer, R.W., Richards, D.A., Scott, E.M., Southon, J.R., Turney, C.S.M., Wacker, L., Adolphi, F., Büntgen, U., Capano, M., Fahrni, S.M., Fogtmann-Schulz, A., Friedrich, R., Köhler, P., Kudsk, S., Miyake, F., Olsen, J., Reinig, F., Sakamoto, M., Sookdeo, A. and Talamo, S., 2020. The IntCal20 Northern Hemisphere Radiocarbon Age Calibration Curve (0–55 cal kBP). *Radiocarbon*, 62 (4), 725–757. Available from: DOI:10.1017/RDC.2020.41

Rud 2015a: Рудь, В.С., 2015. Дослідження залишків жител на розкопі 5 поселення Небелівка. На східній межі Старої Європи. *In*: М.Ю. Відейко, Д. Чапман, І.А. Козир and В.В. Собчук, eds. На східній межі старої Європи / *At the Eastern frontiers of Old Europe. Матеріали міжнародної наукової конференції, Кіровоград, Небелівка, 12–14 травня 2015 року*. Кіровоград: Кіровоградська обласна державна адміністрація и друг, 26–28.

Rud 2015b: Рудь, В.С., 2015. Картографування пам'яток Трипільської культури регіону Південно-Східної Вінниччини. Археологія і Давня історія

України, 4 (17), 134–139. Available from: http://dspace.nbuv.gov.ua/bitstream/handle/123456789/161311/12-Rud.pdf?sequence=1

Rud 2018: Рудь, В.С., 2018. *Трипільська культура півдня лісостепової зони у межиріччі Південного Бугу та Дністра (етапи ВІІ – СІ)*. [PhD thesis. Національна Академія Наук України]. Available from: https://shron1.chtyvo.org.ua/Rud_Vitalii/Trypilska_kultura_pivdnia_lisostepovoi_zony_u_mezhyrichchi_Pivdennoho_Buhu_ta_Dnistra_etapy_VIISI.pdf

Rud *et al.* 2016: Рудь, В.С., Федоров, С.С. and Зайцева, О.В., 2016. Розвідки пам'яток трипільської культури на півдні Вінниччини. Археологічні дослідження в Україні, 2015, 10–12.

Rud, V., Hofmann, R., Kosakivskyi, V., Zaitseva, O. and Müller, J., 2019a. Trypillia Megasites West of the River Southern Buh: Preliminary Results of Bilyi Kamin Site Investigation in 2018. *Journal of Neolithic Archaeology*, 21, 27–60. Available from: DOI:10.12766/jna.2019.2

Rud *et al.* 2019b: Рудь, В.С., Федоров, С.С. and Зайцева, О.В., 2019b. Звіт про роботу Східноподільської археологічної експедиції на території Вінницької області у 2014-2016 роках. Київ: Інститут археології НАН України. Available from: https://elibrary.kubg.edu.ua/id/eprint/29945

Rud, V., Hofmann, R., Kosakivsky, V., Zaitseva, O. and Müller, J., 2022. The Pottery Kilns at the Copper and Late Roman Age Site Hariachkivka 8 (Ukraine): Magnetic Prospection and Archaeological Verification. *XVI International Scientific Conference "Monitoring of Geological Processes and Ecological Condition of the Environment", 15–18 November 2022, Kyiv, Ukraine*. Kyiv: European Association of Geoscientists & Engineers, 1–5. Available from: DOI:10.3997/2214-4609.2022580265

Rud, V., Hofmann, R., Kosakivskyi, V., Zaitseva, O. and Müller, J., 2023. The structure of the Cucuteni–Trypillia multilayered site Kisnytsia on the middle Dnister (Ukraine). *In*: V. Cotiugă, F.-A. Tencariu and A. Asăndulesei, eds. *Fontes perennitatis: Studia in honorem magistri Nicolae Ursulescu octogesimum annum peragentis*. Târgovişte: Cetatea de scaun, 281–294.

Rud *et al.* in prep.: Rud, V., Hofmann, R., Kosakivskyi, V., Müller, J., in prep. *Copper age landscape history between Dnister and Southern Bug, Ukraine (end of 5th – mid. 4th millennium BC)*

Shatilo, L., 2021. *Tripolye Typo-chronology: Mega and Smaller Sites in the Sinyukha River Basin*. Scales of Transformation in Prehistoric and Archaic Societies 12. Leiden: Sidestone Press. Available from: DOI:10.59641/m5457py

Shultse and Liubichev 2019: Шультце, Э.М. and Любичев, В., 2019. Гончарные горны западного и восточного регионов черняховской культуры: новые материалы к вопросу организации гончарного производства. *Археологія і давня історія України*, 30 (1), 189–200. Available from: DOI:10.37445/adiu.2019.01.15

Shumova 1988: Шумова, В.А., 1988. Производство тарной посуды позднетрипольским населением междуречья Ю. Буга и Днепра. *In*: ИА АН СССР, ed. *Древнее производство, ремесло и торговля по археологическим данным. Тэзисы докладов IV конференции молодых учёных ИА АН СССР*. Москва: ИА АН СССР, 29–30.

Țerna, S. and Vornicu-Țerna, A., 2021. The potential of google Earth spatial imagery for detecting Cucuteni-Tripolye settlements: Some examples from ongoing investigation (Republic of Moldova and Northeastern Romania). *In*: A. Diachenko, T.K. Harper, Y. Rassamakin and I. Sobkowiak-Tabaka, eds. *Data Systematization in the Neo-Eneolithic of Southeastern and Central Europe. Essays in honor of Sergej Ryzhov* / Систематизація неолітичних і енеолітичних матеріалів Південно-Східної та Центральної Європи. Збірка наукових праць на пошану Сергія Рижова. Kyiv: Institute of Archaeology of the National Academy of Sciences of Ukraine, 265–305.

Țerna *et al.* 2017: Церна, С.В., Рассманн, К. and Рудь, В.С., 2017. Гончарный горн с позднетрипольского поселения Столничень I (Единецкий район, Республика Молдова) и производство керамики к востоку от Карпат в IV

тысячелетии до н. э. / A Pottery Firing Kiln from the Copper Age Settlement Stolniceni I (Edineţ District, Republic of Moldova) and the Production of Pottery to the East from the Carpathians in IV Millennium BC. *Stratum Plus*, 2017 (2), 301–330.

Țerna, S., Vornicu-Țerna, A. and Rassmann, K., 2018. New data on the formation of complex sites in the Western area of the Cucuteni-Tripolye culture. *In*: И.В. Бруяко, Л.В. Носова and Л.Ю. Полищук, eds. Народи і культури нижнього дунаю в давнину. Матеріали Міжнародної науково-практичної конференції (м. Ізмаїл, 23-26 серпня 2018 р.). Ізмаїл: Одеський Археологічний Музей НАН України, Міністерство Освіти і Науки України Ізмаїльський Державний Гуманітарний Університет, 15–25.

Țerna, S., Vornicu-Țerna, A., Hofmann, R., Dal Corso, M., Shatilo, L., Vasilache-Curoşu, M., Rud, V., Knapp, H., Kirleis, W., Rassmann, K. and Müller, J., 2019. Stolniceni – Excavation results from the 2017 campaign. *Journal of Neolithic Archaeology*, 21, 209–282. Available from: DOI:10.12766/jna.2019.9

Tkachuk and Jakubenko 2002-2003: Ткачук, Т.М. and Якубенко О.О., 2002-2003. Нові дані про локально–хронологічну приналежність поселення Стіна IV. Українознавчі студії, 4–5, 265–274.

Tsvek 2006: Цвек, О.В., 2006. *Поселення східнотрипільської культури (короткий нарис).* Київ: Інститут археології НАН України.

Uhl, R.A., Vasilache-Curoşu, M., Sîrbu, M., Sîrbu, L., Bicbaev, V., Steiniger, D., Zidarov, P., Sava, E. and Hansen, S., 2017. Petreni in der nördlichen Moldaurepublik. Bericht über die Ausgrabungen der Jahre 2011–2013. *Eurasia Antiqua,* 20 (2014), 185–206.

Videiko et al. 2015: Видейко, М.Ю., Чепмэн, Д., Бурдо, Н.Б., Гайдарска, Б., Церна, С.В., Рудь, В.С., and Киосак, Д.В., 2015. Комплексные исследования оборонительных сооружений, производственных комплексов и остатков построек на трипольском поселении у села Небелевка. *Stratum plus*, 2015 (2), 147–170.

Videiko *et al.* 2021: Видейко, М., Рудь, В., Гошко, Т. and Видейко, М., 2021. Трипольские поселения етапа BI-BII на Днепре. *Tyragetia, serie nouă*, 15 [30] (1), 75–94. Available from: https://elibrary.kubg.edu.ua/id/eprint/39468/1/6_Videyko_etal%20%281%29.pdf

Vinogradova 1983: Виноградова, Н.М., 1983. *Племена Днестровско-Прутского междуречья в период расцвета трипольской культуры (периодизация, хронология, локальные варианты).* Кишинев: Штиинца.

Vitsa 1992: Віца, Б.Г., 1992. До історії стародавнього населення на території Крижопільського району. *Етнографія Поділля*, 1992 (2), 8–12.

Wagner, T., 2019. An-Architektur. Politische Aspekte der Siedlungsformen primitiver Gesellschaften. *In*: R. Haude and T. Wagner, eds. *Herrschaftsfreie Institutionen. Texte zur Stabilisierung staatenloser, egalitärer Gesellschaften*. Heidelberg: Verlag Graswurzelrevolution.

Zahoruiko 1993: Загоруйко, В.Т., 1993. *Звіт про проведення археологічної розвідки у Вінницькій області в 1993 році*. Київ: Науковий архів Інституту археології НАН України. [Unpublished report in the Scientific archive of the Institute of Archaeology of the National Academy of Sciences of Ukraine (IA НАН України), archive signature: 1993/50].

Zahoruiko and Shumova 1997: Загоруйко, В.Т. and Шумова, В.О., 1997. Поселення середньої доби трипільської культури на Вінниччині біля с. Гарячківка. *Археологічні дослідження в Україні*, 1993, 52–53.

Zaiets and Ryzhov 1992: Заец, И.И. and Рыжов, С.Н., 1992. *Поселение трипольской культуры Клищев на Южном Буге*. Киев: Киевская типография научной книги.

Zborovskyi 1929: Зборовський, І., 1929. *Щоденник розвідок і розшуків археологічних І. Зборовського в 1929 р. на Тульчинщині.* Київ: Науковий архів Інституту археології НАН України. [Unpublished field walking diary in the archive of the Institute for Archaeology of the National Academy of Science of Ukraine (IA НАНУ), archive signature: 3/90].

15. Miniature ceramic items from Trypillia settlements of South-East Podillia

Natalia Burdo, Vitalii Rud, Robert Hofmann

Abstract

During Ukrainian-German fieldwork carried out between 2017 and 2019 at Trypillia settlements in the Southern Bug-Dniester Interfluve region of Ukraine, numerous miniature ceramic objects were found, amongst other artefacts. This group of items includes anthropomorphic and zoomorphic figurines, house models, miniature vessels and so-called tokens. In this article, we describe and contextualise these objects within the wider framework of the network of the Cucuteni-Trypillia world.

Introduction

Since the end of 20th century a large number of Cucuteni-Trypillia (CT) settlements of different periods have been found in Eastern Podillia (mainly the Vinnytsia oblast of modern Ukraine). However, for a long time the sites of Dniester and Southern Bug interfluve remained less examined (Rud 2018b) than those of the nearby Middle Bug region (Husiev 1995). Therefore, miniature ceramic items from the interfluve settlements have been represented until now only by small collections. However, one of the first ancient discoveries of Trypillia anthropomorphic figurines is connected to the Dniester-Southern Bug interfluve region. This came from Krynychky settlement (Trypillia B2 stage), where Ch. Zborovskyi conducted non-professional archaeological material collecting in 1891–1893. A female figurine was later published by M. Makarenko (1926). It was in the collection of National Museum of the History of Ukraine, but is now lost (Burdo 2013, 246–251). The collection of Krynychky anthropomorphic figurines from examinations by S. Hamchenko and I. Zborovsky in 1909–1913 is presented in the catalogue published by A. Pogoševa (1985, Figs. 652–667).

A collection of several anthropomorphic and zoomorphic figurines was acquired during excavations in 1929 and 1958–1959 at the Stina 4 settlement (Trypillia C1 stage), conducted by S. Hamchenko and M. Makarevych (Burdo 2014a, Fig. 16:

11–14). As a result of the examination of Bilyi Kamin settlement (Trypillia C1 stage) in 1928 by S. Hamchenko, anthropomorphic and zoomorphic figurines were also found (Balabina 1998, 21–24).

Several anthropomorphic figurines were found in the Kyrylivka settlement (Trypillia B2–C1 stage), which was examined in 1955 by A. Esypenko, and in the Cherkasiv Sad II settlement. The analysis of the figurines from the later settlement was presented by L. Polishchuk (1986). An unique hybrid figurine with zoo- and anthropomorphic characteristics also comes from Cherkasiv Sad II settlement (Burdo 2014a, Fig. 16: 15). The Chechelnyk settlement (Trypillia C1 stage) is also represented by anthropomorphic and zoomorphic figurines collected during excavations and investigations by V. Kosakivskyi (1993, Fig. 7: 7–10, 13–14).

Anthropomorphic and zoomorphic figurines of Trypillia B1 and Trypillia B2 stages were found in 2007–2009 during the excavations of the multi-layer Busha settlement by V. Kosakivskyi (Kosakivskyi and Rud 2009, 342, Fig. 5; Kosakivskyi and Rud 2010, Fig. 1: 2).

Each of the collections from most of the settlements mentioned above include around ten figurines; only the collection from Krynychky settlement includes around three dozen items. Ceramic figurines are also known from other settlements, but are stand-alone finds (Rud 2018a, 127–133). There are also ceramic models of sledges from Chechelnyk and Kryvetske settlements of the Trypillia C1 stage (Rud 2018a, 134), as well as house models from Cherkasiv Sad II settlement (Patokova *et al.* 1989, 46–48, Fig. 16: 9). Several ceramic tokens were found in the region, in settlements of Trypillia B2 and Trypillia C1 stages (Rud 2018a, 134).

In 2017–2019 an international research team from Kiel University (Germany) and the Institute of Archaeology of the National Academy of Science of Ukraine (IA NASU; Kyiv, Ukraine) led by V. Rud and R. Hofmann conducted archaeological examinations of many CT settlements in the southern part of Eastern Podillia, in the Southern Bug and Dniester interfluve (*e.g.* Rud *et al.* 2019a). The exploration was conducted as part of fieldwork carried out by the East-Podillia Archaeological Expedition of the IA NASU. The Kiel activities were conducted in the framework of the CRC 1266 'Scales of Transformations' and the sub-project D1 'Population agglomerations at Tripolye-Cucuteni mega-sites'.

During the excavations of different objects, which were mostly identified with the use of geomagnetic equipment (Rud *et al.* 2019c), miniature ceramic artefacts were found. They come from settlements dated from Trypillia B1–B2-Cucuteni AB to Trypillia C2 (Fig. 1). This article describes their characteristics, as they add greatly to the source base.

Methods

In CT various miniature ceramic artefacts are typically found, mainly anthropomorphic and zoomorphic figurines and also models of houses, sledges, tables, throne-seats, axes, dishes *etc.* Most likely, they could not have had utilitarian purpose and so had rich symbolic meaning. Thus, since the discovery of the Trypillia culture, most researchers have considered them to be cult items. The historiographical analysis of views on this topic is represented in the monograph by A. P. Pogoševa (1983, 7–10). One of the exclusions is the interpretation by I. I. Zaiets (2001, 156) of ceramic rattles and miniature vessels as toys.

This article describes 42 ceramic items which come from nine settlements in South-Eastern Podillia. The archaeological context of the finds is presented in Table 1. Chronologically the settlements belong to four successive periods of CT development across more than seven centuries, between 4250 and 3500 BCE. The collection is from six settlements of Trypillia B1–B2-Cucuteni AB stages, and one

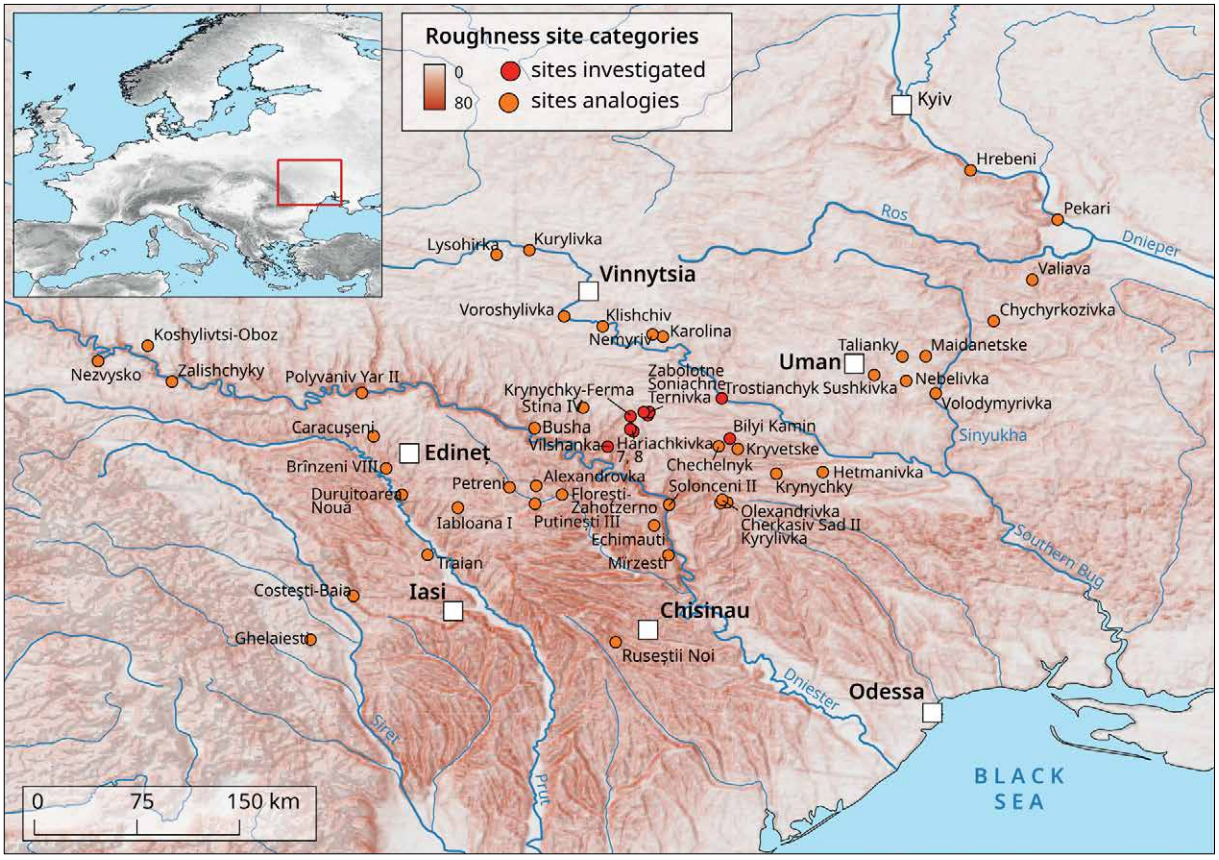


Figure 1. Location of sites with miniature ceramic items presented in this article and of other sites mentioned in this chapter.

settlement from each of Trypillia B2-Cucuteni B1, Trypillia C1-Cucuteni B2 and Trypillia C2 stages.

The artefacts are divided into five groups: anthropomorphic figurines, zoomorphic figurines, miniature vessels, house models, and tokens.

During the collection processing, the characteristics of the artefact technology (the specifics of forming the mass, sculpting process and burning) were studied. Some artefacts have metric signs on them. In some cases, calculation of the possible sizes of complete items was conducted, using extrapolation. The most important part of the work with the collection was to detail the characteristics of the morphological and stylistic specifics of each artefact. Finally, a search for analogies and comparison with collections of synchronous settlements was conducted.

Object characteristics

Trypillia B1–B2-Cucuteni AB

The settlements of Trypillia B1–B2-Cucuteni AB stages (Hariachkivka 8, Hariachkivka 7, Ternivka, Zabolotne, Soniachne and Vilshanka) probably belong to the new, previously unknown local-chronological group(s) of Trypillia B1–B2 stage, judging by comparative examination of the figurine items.

Site (campaign)	Find-ID	Trench	Feature-ID	Feature interpretation	Square	Level
Hariachkivka 8 (2019)	1144	1	1001	House	A12	2
	1181	1	1005		A12	3
	2073	2	2002	Pit near the house	A3	5
	2101	2	2004		D5	6a
	2102	2	2004		D5	6a
	2166	2	2004		B5	7
	2178	2	2004		D5	7
	3020	3	3003	Mega-structure (?)	A4	5
	5009	5	5001	House	B1	1
	5010	5	5002		C1	2
Hariachkivka 7 (2019)	1010	1	1001	Pit near the mega-structure (?)	A1	3
	1020	1	1002		A2	5
Ternivka (2017)	1041	1	1006	House	E1	4
	1135	1	1008	Pit near the house	A2	6
	1215	1	1019		A2	304.65 m asl
Zabolotne (2017)	1001		Surface collection			
	2066	2	2007	Pit near the house	B1	5
	2271	2	2008		A1	11
	3134	3	3006	House	C1	4
Soniachne (2017)	1002	1	1002	Cultural layer		
Vilshanka (2017)	2003	2	Pit 3			
Trostianchyk (2017)	001		Surface collection			
	004		Surface collection			
	4053	2	4004	Ancient surface outside the house	A1	2
	4054	4	4005	House	A5	2
	4144	4	4010	Pit	C3	5
	4205	4	4010		C3	7
	4253	4	4010		B2	4
	6020	6	6001	Materials agglomeration at the house	A3	1
	6183	6	6006	Pit	C3	5
	6206	6	6006		C3	5
	6210	6	6006		B3	5
	6228	6	6006		B3	5
Bilyi Kamin (2018)	3058	3	3004	Pit near the house	A1	Profile 2
	4159	4	4003	House 7	C3	2
	4341	4	4006	Materials agglomeration between Houses 7 and 8	A6	2b
	4400	4	4008	House 7	B7	2b
	4415	4	4006	Materials agglomeration between Houses 7 and 8	B12	2b
	4426	4	4002	Ancient surface outside House 7	H6	2b
	4581	4	4004	House 7	D10	3
	4930	4	4020	Outside House 7	H15	6
Krynychky (2017)	2183	2	2003	Pit	A1	5

Table 1. Archaeological context data.

Hariachkivka 8

From the collection of various objects in the settlement come ten miniature ceramic items, including fragments of six anthropomorphic and two zoomorphic figurines, one ceramic token and one miniature dish.

The largest number of items (three fragments of anthropomorphic figurines and one miniature bowl) were found in Trench 2 in the filling in the bottom part (Feature-ID 2004) of the pit, which is located near the edge of the building of the settlement's inner circle. In the Chernozem layer above the pit, a ceramic horn of a bovine figurine (Find-ID 2073) was found, presumably of medium size (Fig. 2: 5). The clay-matrix is fine-grained and compact, the colour is light-grey.

Among the three anthropomorphic items, one which draws attention is the fragment of an ornamented standing slender female figurine (Find-ID 2178) with closed, relief-modelled legs (Fig. 3: 4). The clay-matrix is fine-grained and compact, without visible admixtures. The colour is orange, which indicates oxidative burning. The height of the fragment is 9.5 cm, the whole item could have been up to 13–15 cm high, which makes this figurine middle-sized. The upper part of the figurine is lost.



Figure 2. Miniature ceramic items from Hariachkivka 8 (1, 3–8) and Hariachkivka 7 (2). Scale 2:3. Find-IDs: 1144 (1), 1010 (2), 2102 (3), 5009 (4), 2073 (5), 5010 (6), 2166 (7), 1181 (8).

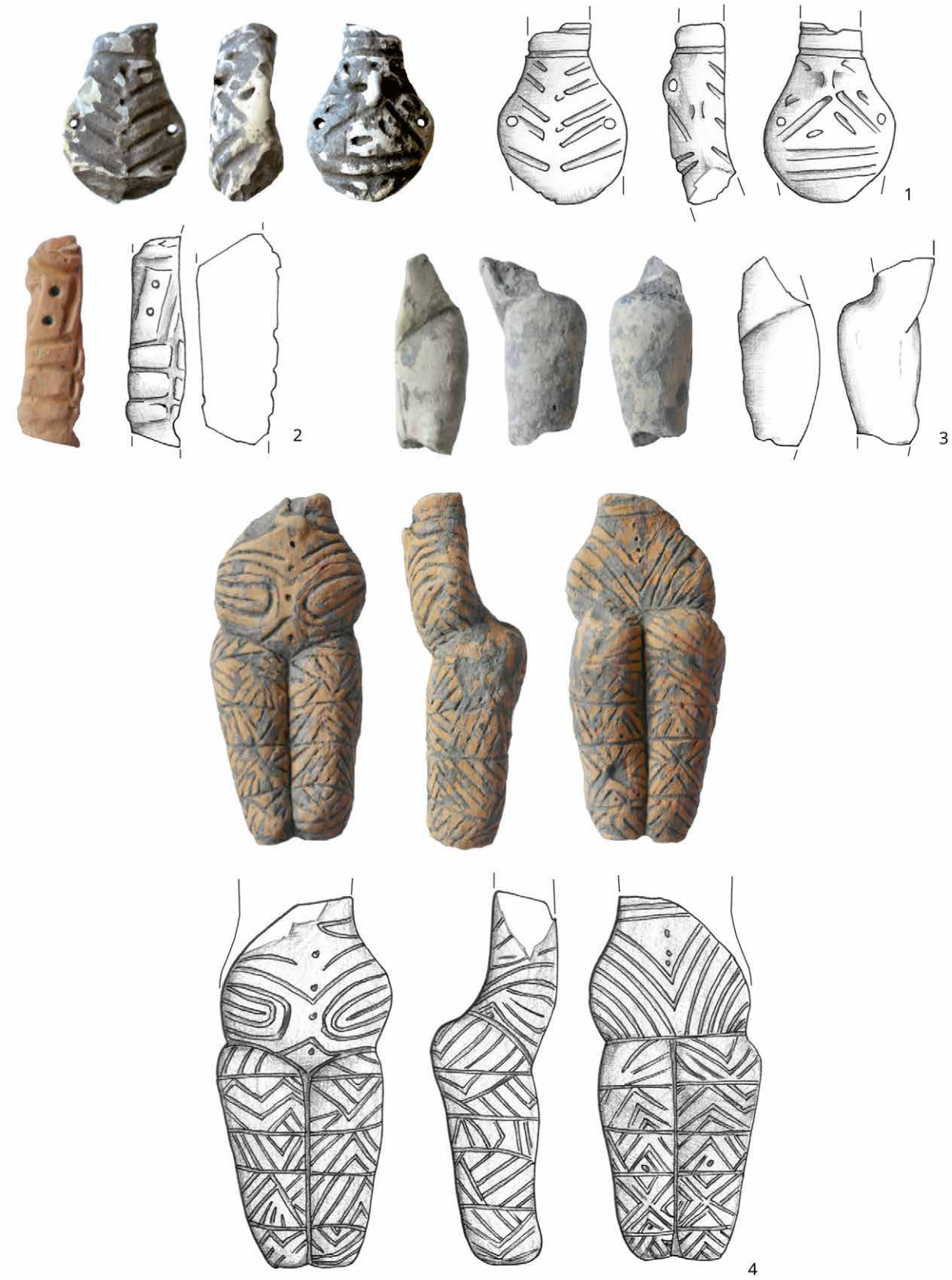


Figure 3. Miniature ceramic items from Hariachkivka 8 (1, 3, 4) and Hariachkivka 7 (2). Scale 2:3. Find-IDs: 3020 (1), 1020 (2), 2101 (3), 2178 (4).

The pose of the standing figurine is as follows: the hips are smoothly outlined, the buttocks are bulging, the upper part of the figurine is leaning forward with a slight deviation to the back.

The decoration, which consists of thin engraved lines, covers the whole surface of the figurine. On the front of the hips is a composition of horizontal concentric ovals with a line in the centre. The bosom is marked as a rhombus with a dot. Three dots are located vertically in the centre from the bosom to the cone on the belly. The legs are encircled by parallel horizontal stripes, filled with triangular shape ornamentation. Behind, on the buttocks and the back, there are V-shaped ornamentations. On the back, below the waist, these create a triangle with the apex pointing downwards; there are three dots located vertically in its centre. The engraved decoration was filled with red paste-like paint, which was preserved on various parts of the figurine.

The character of the composition and the ornamentation of this statue are quite unique. Some analogies in early Trypillian figurines are ovals seen on the hips, but on the figurines from Olexandrivka (Burdo 2014a, Fig. 6: 13) and Ruseștii Noi (Pogoševa 1985, Fig. 365) such elements are represented on the buttocks. The rhombus with a dot on the bosom was also found in the decoration of the figurines at Pre-Cucuteni-Trypillia A (Burdo 2014a, Fig. 6: 14; Pogoševa 1985, Figs. 124, 131–132, 168, 171, 208) and Cucuteni A (Monah 2012, Fig. 52: 10).

The second find from the pit is the right half of the lower part of a non-ornamented anthropomorphic standing slender figurine (Find-ID 2166), medium in size, with closed legs (Fig. 2: 7). The original surface of the item is most likely to be lost. The clay matrix is fine-grained and compact, without visible admixtures; there are microscopic holes made from burnt organics. The clay is most likely to come from river mud. The colour is orange, there are grey stains inside. The fragment shows the method of modelling in two vertical halves, for the lower part of the figurine at least.

The third artefact is an analogical fragment of the lower part of a non-ornamented standing anthropomorphic slender figurine (Find-ID 2101), but in this case it is the left half (Fig. 3: 3). The clay matrix is fine-grained and compact, without visible admixtures. The colour is light-grey. The original surface is most likely lost.

In the pit, in the same context, a complete miniature non-ornamented bowl was found (Find-ID 2102). It is cone-shaped and 4 cm in diameter. It is made of compact fine-grained clay, probably of river mud, with microscopic holes (Fig. 2: 3). The colour is light-orange.

Among the ruins of the mega-structure, a 4 cm high fragment of the torso of a standing ornamented female figurine was found (Find-ID 3020; Fig. 3: 1), at the level of the upper storey of the building. On the belly there is a protrusion with a horizontal hole. In the smoothly outlined hips there are holes. The clay matrix is fine-grained and compact, without visible admixtures. The colour is light-grey. The decoration of wide engraved lines covers the whole surface of the fragment. On the lower part of the belly the lines form a triangle, in the centre of which there are two stripes. Above the protrusion, in the centre, there is a dot, probably related to the vertical line of dots. The waist is encircled by two parallel lines. There is V-shaped ornamentation on the back. The fragment is presumed to come from the figurine of the same type as the one described above, which was also found in the pit. The difference between them lies in the presence of the holes in the hips, which can be considered as some form of signs or symbols.

During the examination in Trench 5 of the remains of the outer circle building in the ploughing layer of Chernozem, a fragment of the upper part of an anthropomorphic slender figurine without ornament was found (Find-ID 5009). The height of the fragment is 3 cm, the figurine was probably middle-sized (Fig. 2: 4). The clay matrix is fine-grained and compact, without visible admixtures. The colour is yellow outside, grey inside. The shoulder protrusions are cone-shaped, with holes. The torso is oval in the cross-section. In front, above the waist there is a vertical line.

Alongside the pieces of burnt clay on the upper storey of the building, a fragment of the lower part of an anthropomorphic non-ornamented sitting figurine (Find-ID 5010) was found. It has closed and 90° bent legs (?) and a modelled foot (Fig. 2: 6). From behind, the legs are divided by a thin line. The clay matrix is fine-grained and compact, without visible admixtures. The colour is orange. Figurines of this type are rare; analogies of such a pose can be found among the artefacts from settlements of Trypillia B2 stage at Nezvysko (Pogoševa 1985, Fig. 526) and Hrebeni (Pogoševa 1985, Fig. 707), from the beginning of Trypillia C2 stage at Koshylivtsi-Oboz settlement (Pogoševa 1985, Figs. 906, 918) and from Cucuteni B in Ghelăieşti (Monah 2012, Fig. 178: 10) and Costeşti-Baia (Monah 2012, Fig. 183: 3).

During the examination of the remains of another building, located outside the outer circle, in the plough-layer of Chernozem, a ceramic token 2 cm in diameter was found (Find-ID 1144), made of fine-grained, compact clay; the colour is light-yellow (Fig. 2: 1).

Among the pieces of burnt clay on the upper storey of the same building, an almost complete 4 cm long zoomorphic figurine (bovine) was found (Find-ID 1181). The clay matrix is fine-grained and compact, with traces of burnt admixtures on the surface. The colour is dark-yellow. The figurine is roughly sculpted; however, the tail and spine ridges are modelled (Fig. 2: 8).

Hariachkivka 7

While examining the pit near the mega-structure, in the Chernozem layer a fragment (5 cm high) of the lower part of an anthropomorphic figurine was found (Find-ID 1020), which was probably modelled from two vertical halves (Fig. 3: 2). The ornamentation consists of wide engraved lines and holes. The closest analogies among figurines come from the settlement of Cucuteni A-Trypillia B1 stage Putinești III (Țerna and Vasilache 2019, Pl. 40, 9/60). The clay matrix is fine-grained and compact, without visible admixtures. The colour is orange. It is possible that the figurine is of the same type as Find-ID 2178 from the Hariachkivka 8 settlement.

From the same location there is a miniature (1 cm in diameter) cone-shaped ceramic token (Find-ID 1010; Fig. 2: 2).

Ternivka

Three vaguely characterised fragments of anthropomorphic figurines come from this settlement. Two fragments were found in the upper layer of the filling of the pit, which is located near the remains of the building of settlement's inner circle. What draws the attention is the fragment of the lower part of a sitting non-ornamented anthropomorphic figurine with straight legs (Find-ID 1215), modelled in two vertical halves (Fig. 4: 3). Figurines in a sitting pose are rare. In Eastern Podillia such figurines are known at the settlements of Trypillia B2 stage Voroshylivka and Karolina (Husiev 1995, Fig. 60: 13, Fig. 63: 5) and also at the Bilyi Kamin settlement of the Chechelnyk group (Fig. 11: 3). The clay matrix of the sitting figurine is fine-grained, compact and has visible holes from organic temper. The colour is orange, indicating oxidative burning. From the same material there is a fragment of the right half of the lower part of a standing anthropomorphic figurine (Find-ID 1135), which probably is also modelled in two vertical halves. Hip protrusions are cone-shaped with a hole (Fig. 4: 2).

A small fragment of a figurine (Find-ID 1041) of the same type (Fig. 4: 1) was found in the layer of soil under the ruins of the burnt wood-clay building. The bulging belly and hip protrusions with holes are modelled.

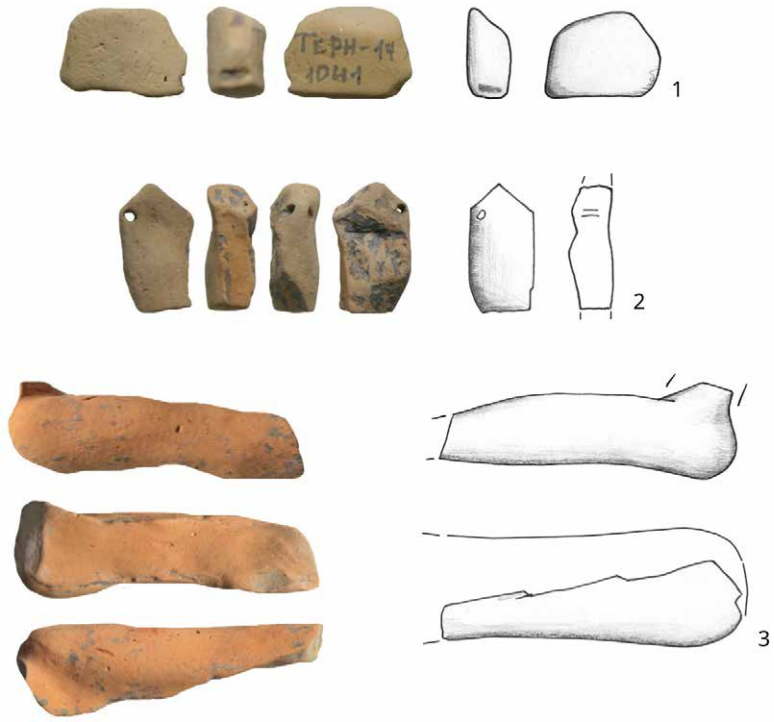


Figure 4. Miniature ceramic items from Ternivka. Scale 2:3. Find-IDs: 1041 (1), 1135 (2), 1215 (3).

Zabolotne

Anthropomorphic figurines are represented by the uncharacteristic fragment (Find-ID 1001) of the lower part of a standing anthropomorphic figurine with cone-shaped legs, found during the examination of the settlement (Fig. 5: 2). The clay matrix is fine-grained and compact. The orange colour indicates oxidative burning.

An almost complete, quite large (4 cm high) bovine figurine (Find-ID 3134; Fig. 5: 4) was found in the soil layer under the ruins of the burnt wood-clay building of the settlement's inner circle. The figurine has realistic features, a detailed sharp muzzle, tail, horns, separately shown legs. The clay matrix is fine-grained and compact, the colour is light-yellow. There is a deep hole on the back of the figurine (denoting a female?). On the surface there are grain imprints (?), one on the withers, one on the left rear leg and two below the tail.

Another zoomorphic figurine (Find-ID 2066), smaller (2.2 cm high), was found in the upper layer of pit filling, located near the edge of the above-mentioned wood-clay building of the settlement's inner circle (Fig. 5: 3). The clay matrix is fine-grained and compact; the colour is light-yellow. The belly of the figurine has a hole. The head of the animal is lost, the tail is not marked, the front and rear legs are modelled together. Such modelling occurs among the zoomorphic figurines of Trypillia B2 stage settlements Brînzeni VIII (Balabina 1998, Fig. 17, Fig. 18: 1), also in the territory of Eastern Podillia in Voroshylivka (Husiev 1995, Figs. 67–68), Busha (Kosakivskyi and Rud 2009, Fig. 5: 5–6), Nemyriv (Balabina 1998, Fig. 20: 2–3) and is also seen in the figurines from the settlements Chychyrkozivka, Maidanetske, Talianki of the Tomashivka local group (Balabina 1998, Fig. 21: 1–3) and Koshylivtsi (Balabina 1998, Fig. 22: 3).

In the lower part of the pit's filling a miniature vessel (Find-ID 2271) with a pair of ear-shaped handles on one side (possibly zoomorphic?) was found. The diameter of the rim is 5 cm. The clay matrix is fine-grained and compact, with admixtures of chaff. The surface is spotted because of the secondary burning; the colour is yellow and black (Fig. 5: 1). It is possible that the initial burning was reduction. The bowl is an item of so-called kitchen ceramics.



Figure 5. Miniature ceramic items from Zabolotne. Scale 2:3. Find-IDs: 2271 (1), 1001 (2), 2066 (3), 3134 (4).

Soniachne

The large lower part of a massive figurine (Find-ID 1002) on a cylindrical leg was found while a profile was being made of the remains of the cultural layer on the edge of the quarry on the site (Fig. 6). The height of the fragment is 8 cm, the height of the whole figurine could have been around 30 cm. The clay matrix is fine-grained and compact, with natural admixture of fine sand and larger mineral admixtures up to 2 mm in diameter. The burning is oxidative. The legs are modelled together and divided with a deepened line behind. The foot is marked in front and behind and is 6.7 cm long.

The figurine from Soniachne settlement indicates that the tradition of large terracotta figurines production begins in the Trypillia B1–B2 stage. Such artefacts are found among the anthropomorphic figurines of Eastern Podillia settlements of Trypillia B2 and Trypillia C1 stages such as Voroshylivka, Nemyriv, Kurylivka, and Lysohirka (Husiev 2009, Fig. 6: 1–6, 8). S. O. Husiev (2009, 315) believes that the height of such figurines was 40–50 cm.

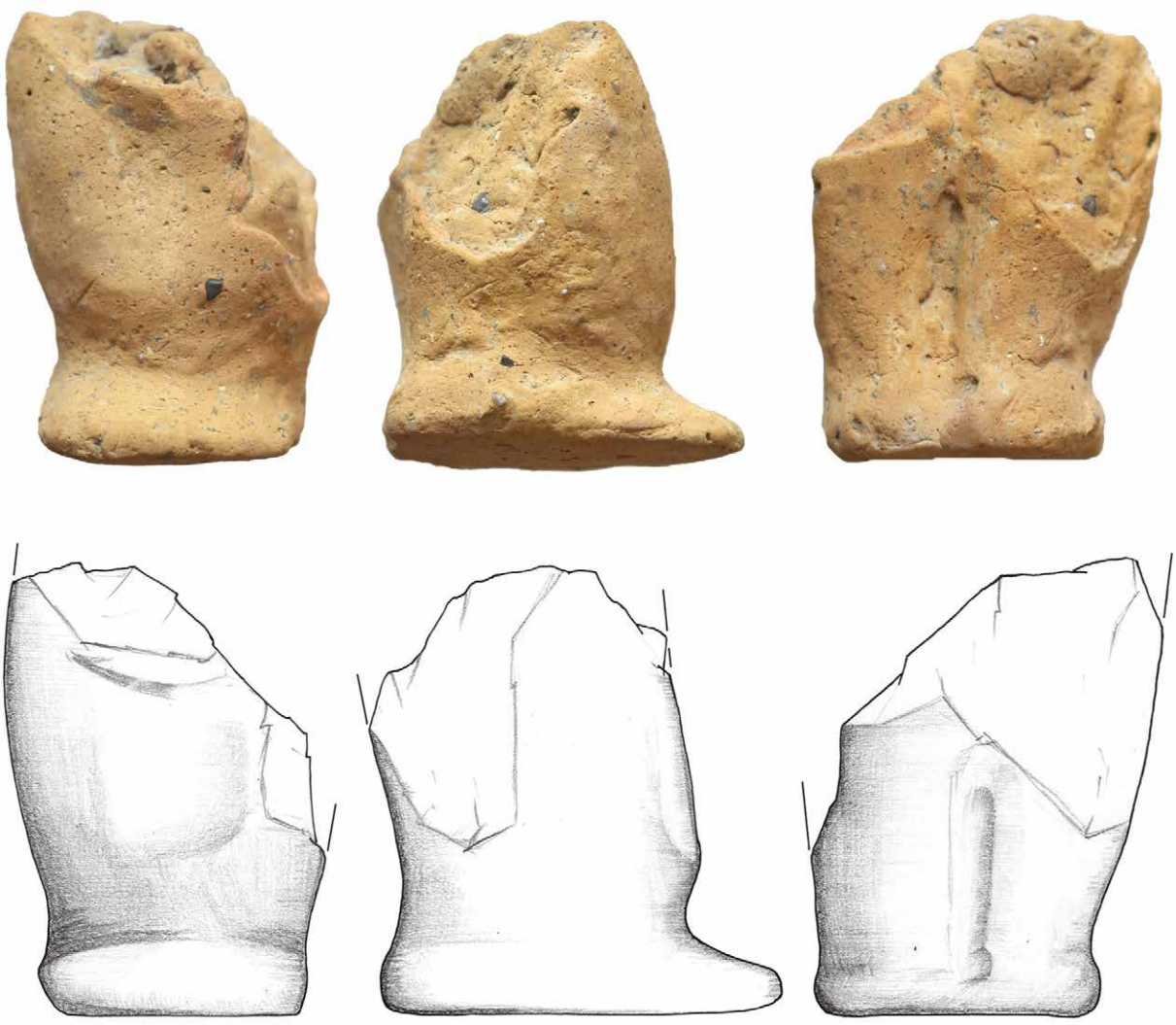


Figure 6. Anthropomorphic figurine (find-ID 1002) from Soniachne. Scale 2:3.

Vilshanka

The fragment of an anthropomorphic ornamented standing figurine (Find-ID 2003) of medium size, modelled from two vertical halves (Fig. 7), was found during pit profile cleaning on the edge of the quarry within the settlement. The clay matrix is fine-grained and compact, the colour is light-yellow. The engraved decoration consists of wide deep lines which cover the facial area of the figurine surface. On the bosom there is a composition of a rhombus and two concentric circles. The legs in front and behind are divided by a vertical line. On the buttocks there are concentric circles. On the hips there is a vertical S-shaped symbol. On the legs there is an ornamentation of parallel stripes. On the back there is a V-shaped ornamentation.

Summary

The small collection of anthropomorphic figurines from the settlements of Trypillia B1–B2 of south-eastern Podillia is represented by the types of figurines which are generally typical for that period. Only 'schematic', anthropomorphic female figurines are represented. Most of them belong to the type of standing, slender figurines with closed legs, shoulder and hip protrusions with holes. Sitting figurines are represented by only two fragments. Most of the finds are not ornamented.



Figure 7. Anthropomorphic figurine (find-ID 2003) from Vilshanka. Scale 2:3.

A specific feature of some figurines is the cone-shaped protrusion with a hole on the belly. The same detail was noticed on the female figurines from settlements of Trypillia B1–B2-Cucuteni AB stage Polyvaniv Yar II (Pogoševa 1985, Fig. 498), Iabloana I (Sorokin and Borziac 2001, Fig. 2: 5, Fig. 7: 2, 4, Fig. 9: 3–4, Fig. 10: 8), Traian (Monah 2012, Fig. 111: 6, Fig. 114: 2–6, Fig. 115: 1–2, Fig. 128: 5).

The anthropomorphic figurines analysed from the settlements of Trypillia B1–B2-Cucuteni AB stage preserve some archaic features, such as modelling in two vertical halves, V-shaped ornamentation and elements of the decoration typical for the Cucuteni A-Trypillia B1 stage (Țerna and Vasilache 2019, Figs. 10–11) and are not typical for the figurines of other settlements of Trypillia B1–B2 stage in the Eastern Podillia region. For example, in the Klishchiv collection there is only one figurine with such features (Zaiets and Ryzhov 1992, Fig. 52: 3). The technique of engraved ornamentation is typical for the figurines from the following settlements of the Solonceni group: Solonceni II (Pogoševa 1985, Figs. 481–482), Mîrzeşti (Sorokin 2004, Fig. 7: 6), Alexandrovka II (Sorokin 2004, Fig. 8: 8–9), Florești-Zahotzerno (Pogoševa 1985, Figs. 515–516), Echimăuți (Pogoševa 1985, Fig. 519), Iabloana I (Sorokin and Borziac 2001, Fig. 5: 5, Fig. 6: 1–3, 5–6, Fig. 7: 1, Fig. 9: 5) and Polyvaniv Yar II (Pogoševa 1983, Figs. 486–489, 493). The ornamental compositions of the examined figurines from South-Eastern Podillia have features similar to those of the figurine decoration from Olexandrivka II settlement. There are similar V-shaped lines on the backs of some figurines from the settlements Hariachkivka 8 (Fig. 3: 1, 4) and Iabloana I (Sorokin and Borziac 2001, Fig. 9: 5), Mîrzeşti (Sorokin 2004, Fig. 7: 6), Polyvaniv Yar II (Pogoševa 1985, Fig. 487). Figurines with engraved decoration

are also known from the settlement Pianizhkove of the Trypillia B1–B2 stage (Burdo 2014a, Figs. 10: 12–13, 15). However, the engraved decoration on the figurines from different settlements has many site-specific features, despite the small number of items in the examined collection.

Trypillia B2–Cucuteni B1

The settlements of Trypillia B2-Cucuteni B1 are represented by Trostianchyk settlement, which belongs to the Mereșeuca (Mereshovka) group.

Trostianchyk

Twelve miniature ceramic items were found among various objects in the Trostianchyk settlement (Rud *et al.* 2018; Rud *et al.* 2019b; Rud *et al.* 2021).

A fragment (4 cm high) of the upper part of a large painted figurine (Find-ID 6020) was found among different types of artefacts in the agglomeration above the ruins of the burnt building. It is made of fine-grained, compact clay (Fig. 8: 1). The burning is oxidative, the colour is orange. On the fracture area there are holes from burnt organic admixtures and grain prints. The surface of the figurine is smoothed with a thin layer of the same clay. The bulging belly is modelled, symbolising pregnancy. The ornamentation consists of dark-brown stripes in chevron-shaped ('^') compositions in front and on the back. A horizontal line encircles the hips. On the bulging belly there are three parallel vertical lines – this ornamentation element does not have an analogy.

Analogies for this figurine's ornamentation are found in figurines from Trypillia B2-Cucuteni B stages, from settlements of different local groups: Volodymyrivka (Iakubenko 2011, Pl. III: 55, 58), Caracuşeni (Pogoševa 1985, Fig. 607), Krynychky (Pogoševa 1985, Fig. 653), Brînzeni VIII (Sorokin 2001, Fig. 10: 1), Valiava (Ovchynnykov 2014, Fig. 108: 4) and, more distantly, from the Costeşti-Baia settlement (Monah 2012, Fig. 146: 9). The analogical scheme of ornamentation is also present on the slender figurines of another type, with spindle-shaped leg, from the settlements Volodymyrivka (Pogoševa 1985, Fig. 571) and Ghelăeşti (Monah 2012, Fig. 215: 2–3).

Under the layer of burnt clay of this building, a pit was discovered which contained two parts of zoomorphic figurines and two fragments of anthropomorphic sculptures, among them the large (8 cm high) upper part of a female figurine (Find-ID 6210). The clay matrix is fine-grained and compact, possibly with the admixture of mica. The colour is inconsistent, from white, light-grey to grey in the centre (Fig. 9: 4). A grey stain is visible on the back. The surface of the figurine is covered with a layer of light engobe; traces of vertical smoothing are clearly visible. There are remains of painting with red paint. The figurine is massive; the head is disk-shaped with large eye holes, the neck is almost absent. The shoulder protrusions are massive and conical, with large holes. The breasts are represented by small bulging protrusions. The torso is oval in form.

Another fragment (2 cm high) from this pit is part of a small anthropomorphic figurine (Find-ID 6183). Presumably, it was in a sitting pose with the body bent back (Fig. 8: 2). The clay matrix is fine-grained and compact, the colour is light-grey, almost white.

A damaged zoomorphic figurine (Find-ID 6206), presumed to be bovine, is 6 cm in length (Fig. 8: 4). The clay matrix is fine-grained and compact, the colour is yellow. The front and rear limbs are joined, resembling a ledge. On the right side there are random pin traces, which stem from before the figurine was burnt. It is possible that these are signs connected with magic activities or this is a decor that imitates animal fur. A badly characterised fragment, 1.5 cm in length, is all that remained of

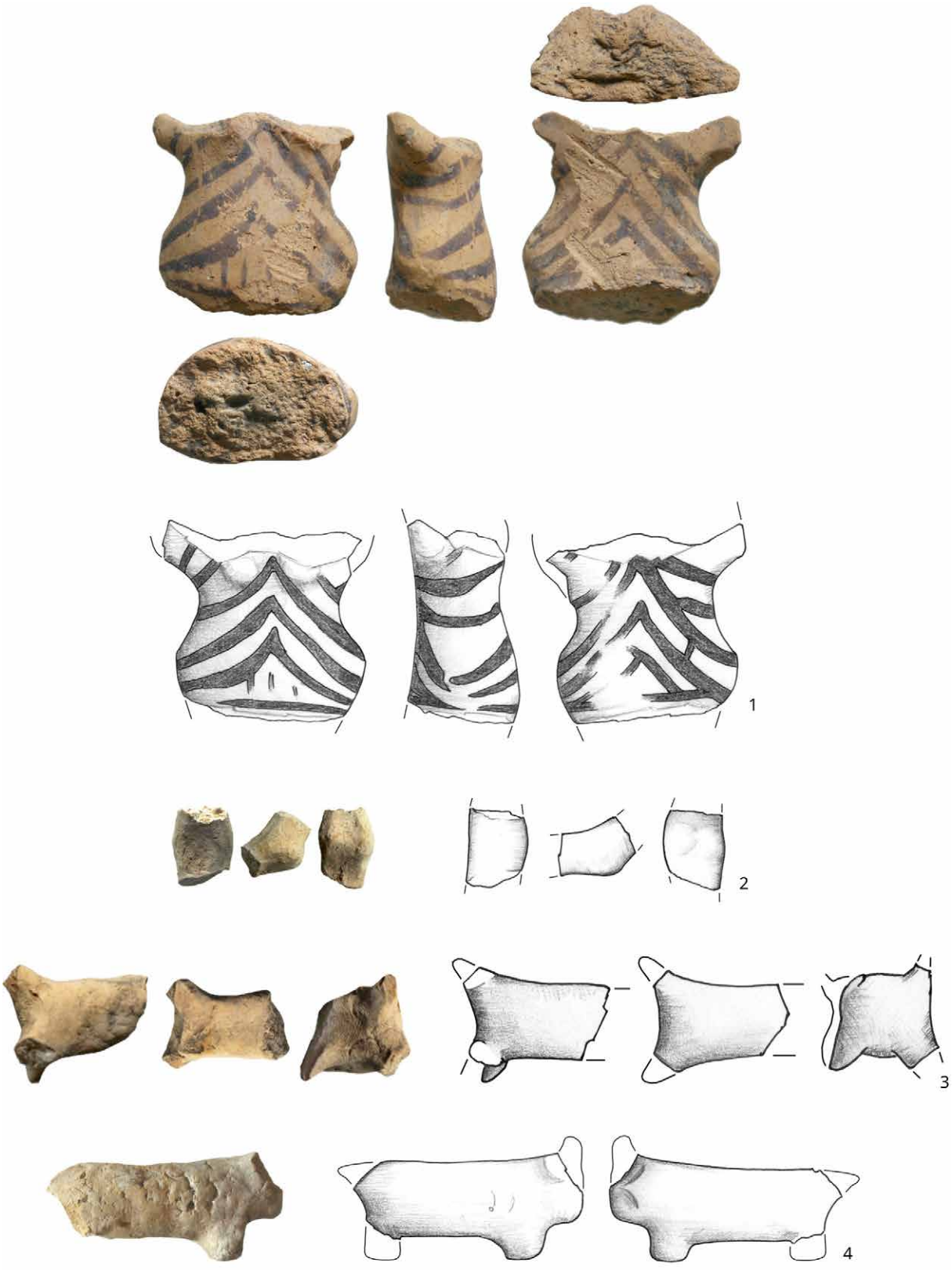


Figure 8. Miniature ceramic items from Trostianchyk. Scale 2:3. Find-IDs: 6020 (1), 6183 (2), 6228 (3), 6206 (4).



Figure 9. Miniature ceramic items from Trostianchyk. Scale 2:3. Find-IDs: 4054 (1), 4053 (2), 4205 (3), 6210 (4).

another zoomorphic figurine (Find-ID 6228; Fig. 8: 3). The clay matrix is fine-grained and compact, the colour is light-grey.

In Trench 4 the heads of two anthropomorphic figurines were found. The first of them was found at the level of the ancient surface. The disk-shaped head (Find-ID 4053) has a thin neck and big ovals for eyes (Fig. 9: 2). The height is 2.8 cm. The clay matrix is fine-grained, kaolinite. The colour is pink inside, white outside. Another head (Find-ID 4054) of analogical type has a very long neck which equals the height of the head (Fig. 9: 1). The height of the fragment is 4 cm. The clay matrix is fine-grained and compact. There are holes from organic temper. The colour is orange. The fragment was found among the ruins of the burnt building.

In the lower part of the pit's filling, which is located near the burnt building, three miniature ceramic items were found. The middle-sized fragment (4.5 cm high) is from an ornamented anthropomorphic figurine (Find-ID 4205) standing on a spindle-shaped leg (Fig. 9: 3). The clay matrix is fine-grained and compact, the colour is pink. The surface of the figurine is polished. The ornamentation is coloured dark-brown; on the lower part of the figurine there is a plant symbol ('the tree' or 'the branch'). A similar 'tree'-like decoration appears on a figurine from the Koshylivtsi settlement; however, the 'tree' isdifferently depicted (Burdo 2014a, Figs. 21: 12). The closest analogies to the ornamentation on the spindle-shaped leg of the figurine from Trostianchyk were found among the figurines at Volodymyrivka settlement (Iakubenko 2011, Tab. III: 69, 72, Tab. V: 93–94).

Another fragment of a figurine (Fig. 10: 2) is most likely to be part of an ornithomorphic hollow figurine – a rattle (Find-ID 4253). The clay matrix is fine-grained and compact, the colour is light-pink. The engobe is orange, the painting is brown. Such finds are typical for CT figurines; the closest ornamentation style is found at the settlements of Brînzeni VIII (Balabina 1998, Fig. 101), Pekari II (Ovchynnykov 2014, Fig. 120: 7) and Hetmanivka I (Kiosak *et al.* 2014).

In the pit there was also a miniature (4.5 cm high) bulging ornamented goblet (Find-ID 4144; Fig. 10: 1). The clay matrix is fine-grained, compact and kaolinite, the colour is light-yellow. On the neck, there are circular holes on opposite sides, probably for hanging. The brown ornamentation is hardly visible.

In addition, from the field walking at Trostianchyk settlement there are two fragments of ceramic items, which can be considered as possible pieces of ceramic house models. The first one is a fragment of an ornamented ceramic artefact (Find-ID 001) of kaolinite clay, almost white. The dark-brown ornamentation is applied over light-yellow engobe (Fig. 10: 3). Another fragment of the artefact (Find-ID 004) is made of smoothed fine-grained, compact clay; it is red in colour (Fig. 10: 4).

Summary

The anthropomorphic figurines from Trostianchyk settlement represent the diversity of clay masses, stylistic and morphological details. This is also seen at the other settlements of the Trypillia B2 stage. The figurines with disk-shaped head and holes for eyes, as well as slender figurines on a spindle-shaped leg with thickening in the calves, are typical for the settlements of Trypillia B2-Cucuteni B.

Such modelling of the lower part of the figurines appears at the stage Trypillia B1–B2-Cucuteni AB, and was typical for figurines of the Trypillia B2 stage at Mereșeuca (Pogoševa 1985, Figs. 613–616, 641–644, 654–655; Sorokin 2001, Fig. 1: 3–4, 6–7, Fig. 2: 5, Fig. 3: 4, Fig. 5: 5, Fig. 6: 3), Serednii Buh (Husiev 1995, Fig. 59: 7, 9), Volodymyrivka (Iakubenko 2011, Tab. I: 14–16, 28, Tab. III: 70–73), Nebelivka (Burdo 2014a, Fig. 13: 4, 6–7, 13) and Kaniv (Ovchynnykov 2014, Fig. 108: 7–14) groups, as well as settlements of the Cucuteni B phase (Monah 2012, Fig. 132, Fig. 133: 1–3, Fig. 134, Fig. 149: 8–10).

The figurines from the Trostianchyk settlement closely resemble the figurines from the settlements of Volodymyrivka (Iakubenko 2011) and Brînzeni VIII

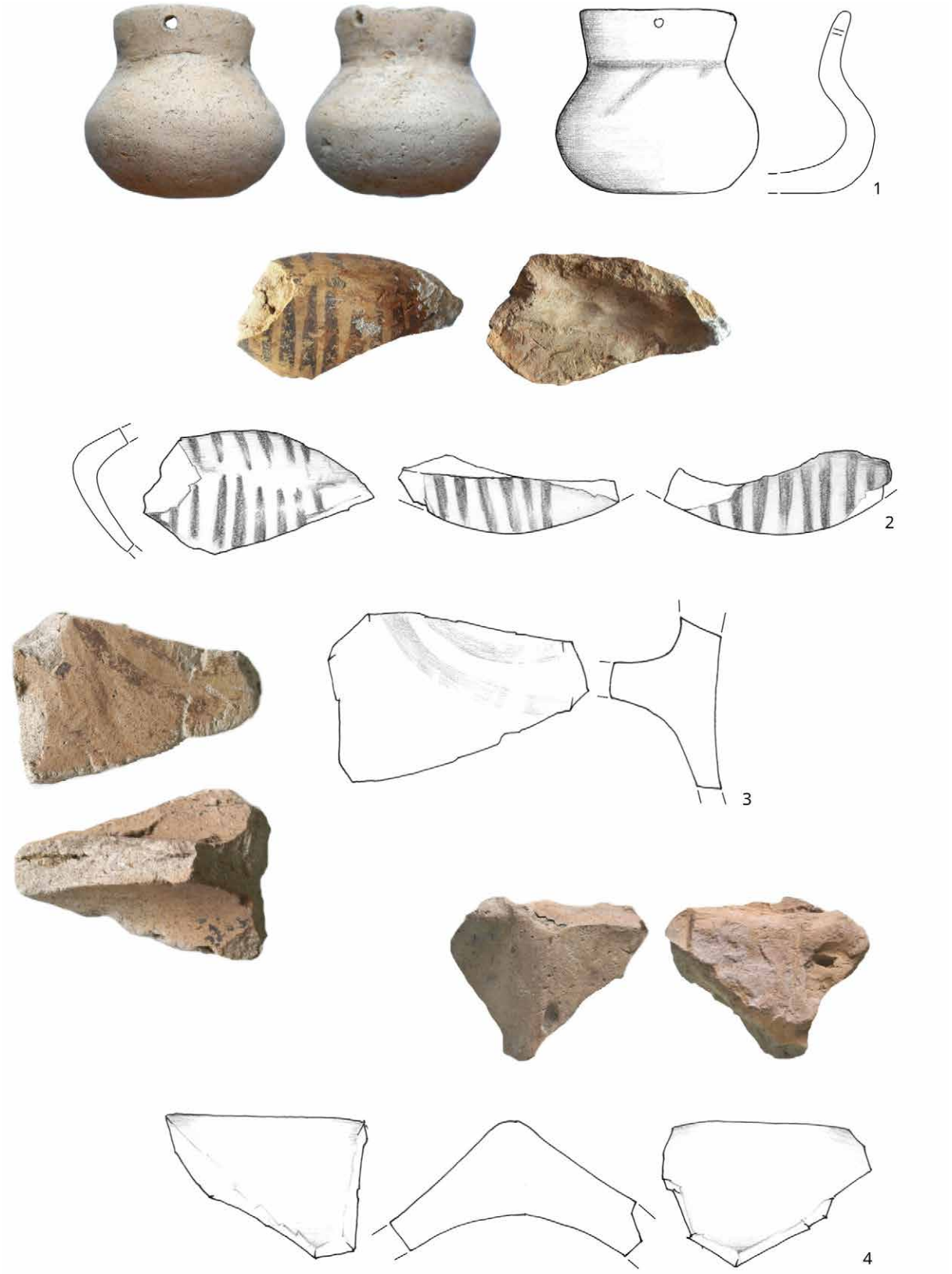


Figure 10. Miniature ceramic items from Trostianchyk. Scale 2:3. Find-IDs: 4144 (1), 4253 (2), 001 (3), 004 (4).

(Sorokin 2001). Unlike the morphological features typical for Trypillia B2 figurines, the ornamental schemes of Trostianchyk artefacts have no direct analogies. For instance, the ornamented figurines from Busha, a settlement geographically and chronologically close to Trostianchyk (Kosakivskyi and Rud 2009, Fig. 5: 1, 3) have similar iconography but a different style of ornamentation.

Trypillia C1-Cucuteni B2

The Trypillia C1-Cucuteni B2 stage is represented by the Bilyi Kamin settlement, which belongs to the Chechelnyk local group. The miniature ceramic items were found in Trenches 3 and 4. The detailed description of the archaeological features from these trenches has already been published (Rud *et al.* 2019a).

Bilyi Kamin

Eight fragments of anthropomorphic figurines were found at the settlement, seven of them in Trench 4, which links them to the fully excavated house №7 of the settlement's outer circle and nearby objects.

On the level of the ancient surface near house №7, a small (4.8 cm high) standing, slender anthropomorphic figurine (Find-ID 4426) with spindle-shaped closed legs was found. The upper part of the figurine is lost (Fig. 11: 5). There is a vertical hole on the fracture area. The clay matrix is fine-grained and compact, with the admixture of sand. The colour is light-grey. No ornamentation.

On the upper-storey level of house №7 in the area of the central clay installation, two female figurines were found.

One is the upper part of a middle-sized (8 cm high) female standing figurine (Find-ID 4159) with a disk-shaped head (Fig. 11: 4). Presumably this fragment comes from the figurine with a spindle-shaped leg. The burning is oxidative, the colour is light-orange. The clay matrix is smooth, fine-grained and compact. There are small mineral admixtures, and microscopic holes from organic temper. Bulging breasts and protruding belly (possible pregnancy) are modelled. Pits are made on the place of the eyes; there are also holes on the shoulders and hips. Ornamentation is not preserved.

The second figurine (Find-ID 4400) is of the same type and is almost the same size (7.3 cm high); the head and lower part of the legs are lost. The clay matrix is fine-grained and compact. There are holes from organic temper. The colour is black and light-yellow. The breasts are represented by protrusions and cone-shaped hip protrusions with holes. There is a small protrusion with a horizontal hole on the belly. The bosom and jewellery (and/or clothes) are shown with frontal engraved lines on the neck and breasts. In the lower part of the figurine, in the centre, there is a hole (Fig. 12: 2). The height of these two figurines could have been 11 to 13 cm.

The upper storey of house №7 is connected to the find of the bust of a small female figurine (2 cm high) with disk-shaped head (Find-ID 4581; Fig. 11: 1). The burning is oxidative, the colour is light-orange. The clay matrix is smoothed, fine-grained and compact. There are small mineral admixtures and visible microscopic holes from organic temper. The neck is almost absent, the bulging breasts are modelled, the shoulders are rounded, barely protruding. Holes for eyes and on the shoulders are absent.

Two fragments of massive figurines were found among the cluster (Feature-ID 4006) of different pieces of artefacts (ceramics, animal bones) at the level of the ancient surface between houses №7 and №8.

There is a large fragment (5 cm high) of the lower part of a massive anthropomorphic figurine (Find-ID 4341) standing on a spindle-shaped leg. The legs are separated in front and behind (Fig. 12: 1). The clay is kaolinite, fine-grained and compact, with the admixture of sand. The colour is light-grey. There are traces of dark-brown decoration.

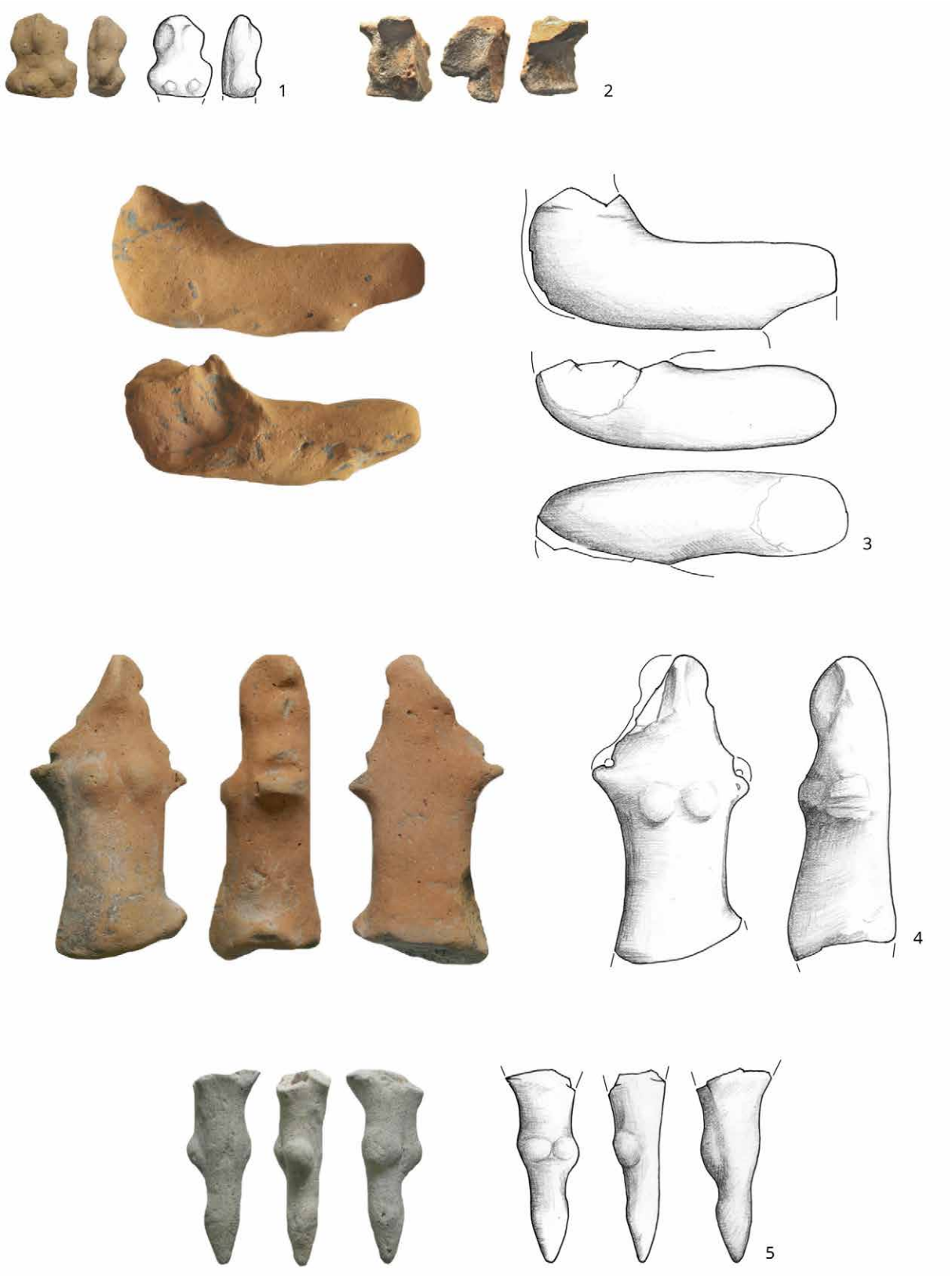


Figure 11. Miniature ceramic items from Bilyi Kamin. Scale 2:3. Find-IDs: 4581 (1), 4930 (2), 3058 (3), 4159 (4), 4426 (5).

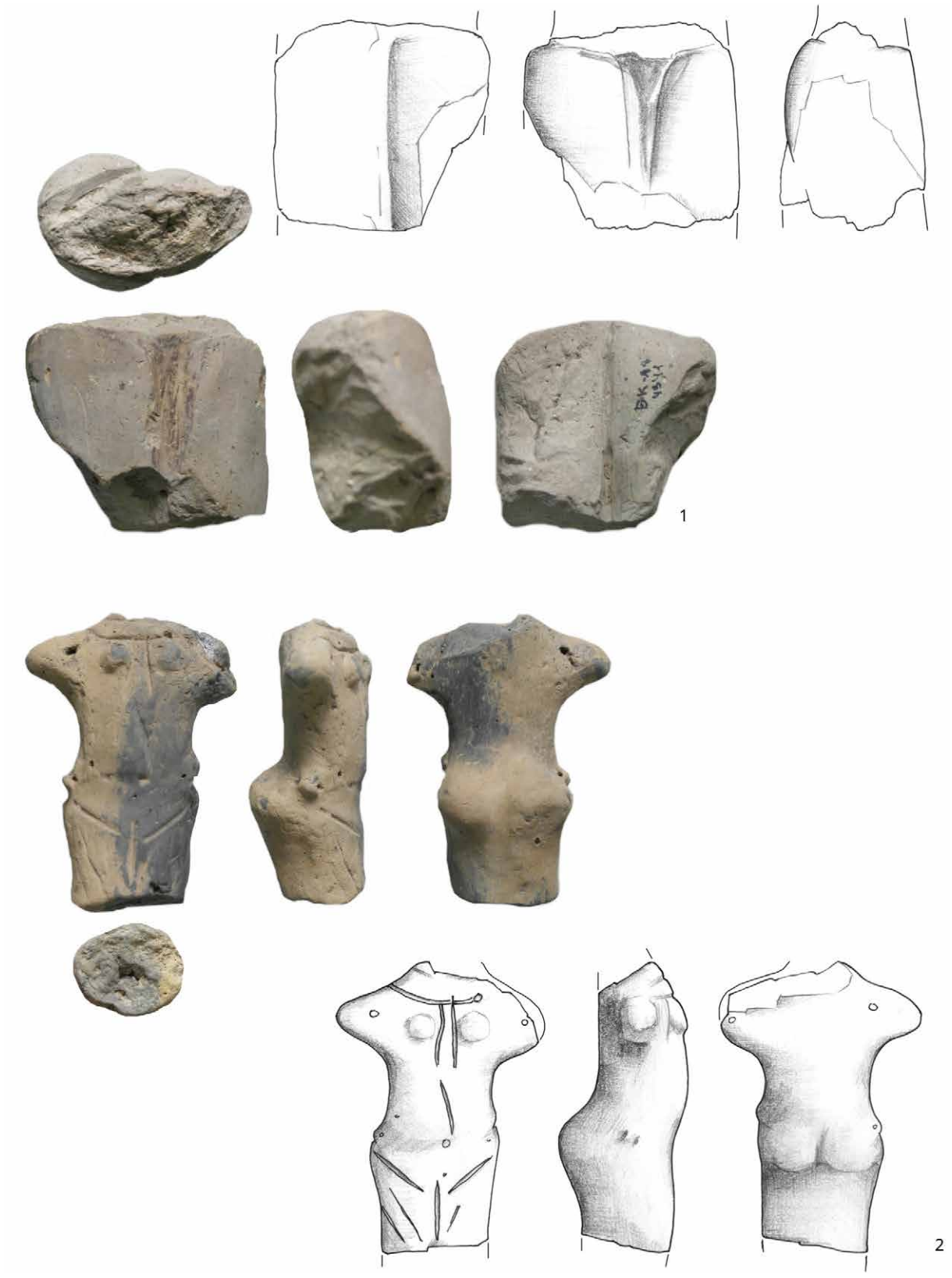


Figure 12. Miniature ceramic items from Bilyi Kamin. Scale 2:3. Find-IDs: 4341 (1), 4400 (2).

A large fragment (8.5 cm high) was found of the lower part of an anthropomorphic figurine (Find-ID 4415) of the same type. The clay matrix is smoothed, fine-grained and compact. There are small mineral admixtures and visible holes from organic temper. The burning is oxidative, the colour is orange. Going down from the buttocks, there is a vertical line indicating the division between the two legs. In the centre of the right buttock there is a grain imprint (Fig. 13: 1).

In the loam near the eastern corner of house №7 a disk-shaped head with headgear of an anthropomorphic figurine (Find-ID 4930) was found. The clay matrix is fine-grained, without admixtures, yellow in colour. There are two small holes on the edges of the head. The headgear has the form of a horizontal disk (Fig. 11: 2).

One figurine (Find-ID 3058) comes from the upper layer of the pit filling in Trench 3. The pit is located near the building of the radial row which is located inside the settlement's inner circle. It is the right half of the lower part of a sitting anthropomorphic figurine (8 cm long) with bent knees (Fig. 11: 3). The legs may have been separated, but there is no break traced on the inner side of the legs. The clay matrix is smoothed, fine-grained and compact. There are holes from organic temper. The colour is orange, the burning is oxidative. The lower part at least of this figurine was modelled in two halves; the deepening on the buttocks indicates the connection of the halves using the slot technique. Such a technique was noticed, for example, in the fragment of the lower part of a sitting figurine from the Cucuteni A-Trypillia B1 stage Duruitoarea Nouă settlement (Țerna and Vasilache 2019, Pl. 22, 4/2).

Summary

The figurines from Bilyi Kamin settlement greatly extend our understanding of anthropomorphic figurines of the Chechelnyk group. Those represented have disk-shaped heads with or without holes for eyes. One head with headgear has two small holes on each side.

In the collections from the Chechelnyk group settlements Cherkasiv Sad II (Polishchuk 1986; Burdo 2014a, Fig. 16: 7, 9) and Kyrylivka (Burdo 2014a, Fig. 16: 10) most figurines are slender females standing on spindle-shaped legs with thickening in the calves. In Bilyi Kamin settlement fragments of upper and lower parts of figurines of this type (Fig. 11: 1, 5) were found. Such modelling of the lower part of figurines occurs in Trypillia B1–B2-Cucuteni AB stage and is typical for figurines in the Trypillia B2-Cucuteni B stage (Monah 2012, Fig. 132, Fig. 133: 1–3, Fig. 134: 1, Fig. 149: 8–10). In the Trypillia C1 stage such figurines can be found in the settlements of Petreni (Pogoševa 1983, Fig. 680; Burdo 2014a, Fig. 17: 2–3), Shypyntsi (Burdo 2014a, Fig. 16: 1) and Kaniv (Ovchynnykov 2014, Fig. 109: 7, Fig. 114: 10) groups.

Four fragments represent massive figurines standing on columnar legs (Fig. 11: 4, Fig. 12: 1–2, Fig. 13: 1). Figurines of the same type are present in the Chechelnyk group settlements including Chechelnyk (Zaiets 2001, Fig. 54: 6), Cherkasiv Sad II (Polishchuk 1986, Fig. 2: 3) and Stina 4 (Burdo 2014a, Fig. 16: 12). The most ancient example of this type was found at the Trypillia B1–B2 stage Zalishchyky settlement (Pogoševa 1985, Fig. 479). In the Trypillia B2 stage such figurines are known from the settlements Brînzeni VIII (Sorokin 2001, Fig. 8: 1) and Nebelivka (Burdo 2014b, Fig. 1: 1). This type is common for the settlements of the Tomashivka group, such as Sushkivka (Burdo 2014a, Fig. 18: 11, 13), Maidanetske (Burdo 2011, Fig. 2: 2) and Chychyrkozivka (Hirnyk and Videiko 1989, Fig. 1). Figurines on columnar legs are also known in the complexes of Petreni (Burdo 2014a, Fig. 17: 9), Kaniv (Ovchynnykov 2014, Fig. 110: 6, Fig. 113: 3, Fig. 118: 9) and Koshylivtsi groups (Pogoševa 1985, Figs. 855–859) and in the settlements of Cucuteni B stage (Monah 2012, Fig. 143: 1, 7, Fig. 150: 6, Fig. 167: 1–2, 4). In summary, the collection of Bilyi Kamin figurines indicates the morphological synthesis of anthropomorphic figurines of different Cucuteni-Trypillia local-chronological groups.

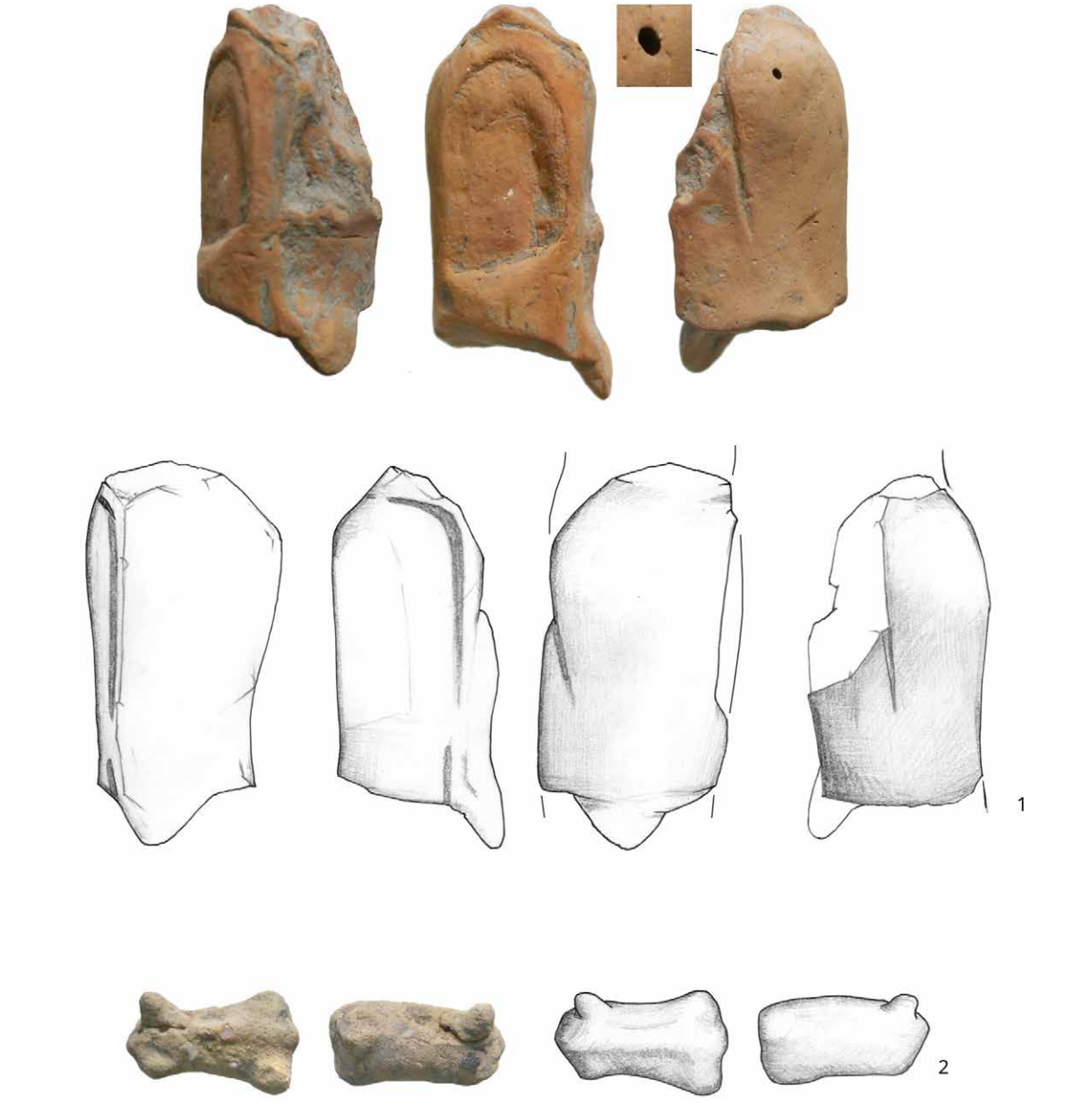


Figure 13. Miniature ceramic items from Bilyi Kamin (1) and Krynychky-Ferma (2). Scale 2:3. Find-IDs: 4415 (1), 2183 (2).

Trypillia C2

Krynychky-Ferma

The Trypillia C2 stage is represented by the only find of a zoomorphic figurine – the bovine from the pit filling of Trench 2 in the Krynychky-Ferma settlement (Fig. 13: 2), which belongs to the Brînzeni local group. The clay matrix is fine-grained with the admixture of quartz. The colour is light-yellow. The tail of the animal is modelled.

Conclusion

Most of the miniature ceramic artefacts (Tab. 2) examined from Trypillia settlements in South-Eastern Podillia are fragments of anthropomorphic figurines. There are 27 of these items, which are a great addition to our knowledge of this category of Trypillia artefacts. Eleven of them are the lower parts of the figurines, six are fragments of middle parts, six are the top parts, three are heads. Only three of the figures are preserved at 70–80%. All of these figurines are 'schematic', most of them are standing; only four fragments are of sitting figurines. What draws the attention is the figurines modelling in two vertical halves from the settlements of Trypillia B1–B2, B2 and C1. In two cases the connection of the halves was done using the slot technique. Such a technique was previously unknown for anthropomorphic figurines. There are female figurines, as well as anthropomorphic figurines without gender signs, which we also consider female.

Most of the figurines have no ornamentation (or it was not preserved), four figurines from the settlements of Trypillia B1–B2 stage have engraved decoration, two figurines from Hariachkivka 8 and one from Bilyi Kamin settlement have some details marked by engraved lines, two figurines from Trostianchyk settlement and one from Bilyi Kamin settlement are painted with dark-brown paint. The decoration of figurines from the Hariachkivka 8 settlement of the Trypillia B1–B2 stage continues the pre-Cucuteni traditions and finds analogies in the figurines of Trypillia A and Trypillia B1.

The collection of the figurines, which comes from one region with a wide chronological range, from Trypillia B1–B2 to Trypillia C2, represents the transformation of figurine main features over more than seven centuries and the lineage of specific traits of the figurines from settlements of different times, as well as local specifics.

Zoomorphic figurines are rare within the examined collection, there are only eight of these. Four of them come from Trypillia B1–B2 sites, three from Trypillia B2 settlements, one from a Trypillia C2 settlement. What draws the attention is that unlike fragmented anthropomorphic figurines, the zoomorphic ones (four items) are usually complete. All of the zoomorphic figurines are 'schematic'. Six of them belong to the bovine class, one to the bird class, after V. I. Balabina (1998). The

Table 2. Distribution of the analysed miniature ceramic items by groups and chronology.

Sites	Anthropomorphic figurines	Zoomorphic figurines	Miniature vessels	House models	Tokens
Trypillia B1–B2-Cucuteni AB					
Hariachkivka 8	6	2	1		1
Hariachkivka 7	1				1
Ternivka	3				
Zabolotne	1	2	1		
Soniachne	1				
Vilshanka	1				
Trypillia B2–Cucuteni B1					
Trostianchyk	6	3	1	2	
Trypillia C1–Cucuteni B2					
Bilyi Kamin	8				
Trypillia C2					
Krynychky		1			
Total	**27**	**8**	**3**	**2**	**2**

bovine class is represented by mostly similar artefacts typical for the settlements from Trypillia B1–B2 to Trypillia C2.

The fragments of ceramics which are parts of house models have neither specific features, nor do they provide much information. By the signs that are visible they appear to be parts of closed-type artefacts. Ceramic tokens are interpreted as 'symbols of a volumetric sign system, connected to rituals and calculation processes' (Videiko 2004; see also Uhl 2018). Miniature vessels are represented by three finds. They reflect the morphological types of ceramic vessels.

Thus, the collection of small plastic objects, on the one hand, fits into the typical Trypillian set of such objects, and on the other, brings additional understanding of the development and transformation of such objects in South-Eastern Podillia, especially for such a poorly studied Trypillian period as B1–B2.

Acknowledgements

The research was funded by the German Research Foundation (DFG), project number 290391021 – SFB 1266. The text was translated by the authors, Danylo Klochko and Olha Zaitseva. We express our gratitude to O. Shelekhan for preparing the drawings of the ceramic items included in this chapter.

References

Balabina 1998: Балабина, В.И., 1998. Фигурки животных в пластике Кукутень-Триполья. Москва: Российская Академия Наук, Институт Археологии.

Burdo 2011: Бурдо, Н.Б., 2011. Антропоморфна пластика з трипільського поселення Майданецьке. *Археологія*, 2011 (2), 3–16. Available from: http://dspace.nbuv.gov.ua/handle/123456789/67536

Burdo 2013: Бурдо, Н.Б., 2013. *Реалистическая пластика культурного комплекса Триполье-Кукутень. Систематзация, типология, интерпретация*. Saarbrücken: LAP Lambert Academic Publishing.

Burdo, N., 2014a. Anthropomorphic plastic art of Trypillia culture: dialectic of similarities and differences. *In*: C.-E. Ursu and S. Țerna, eds. *Anthropomorphism and symbolic behaviour in the Neolithic and Copper Age communities of South-Eastern Europe*. Suceava: Editura Karl A. Romstorfer, 303–364.

Burdo 2014b: Бурдо, Н.Б., 2014b. Антропоморфні фігурки трипільського поселення Небелівка. *Археологія і давня історія України*, 1 (12), 79–83. Available from: http://dspace.nbuv.gov.ua/bitstream/handle/123456789/89597/09-Burdo.pdf?sequence=1

Hirnyk and Videiko 1989: Гірник, І.П. and Відейко, М.Ю., 1989. Антропоморфна пластика з трипільського поселення біля с. Чичиркозівка Черкаської області. *Археологія*, 1989 (1), 83–90.

Husiev 1995: Гусєв, С.О., 1995. Трипільська культура Середнього Побужжя рубежу IV–III тис. до н. е. Вінниця: Антекс–УЛТД.

Husiev 2009: Гусєв С.О. 2009. Антропоморфна пластика середньобузької локальної групи трипільської культури (етапи BI – BII – CI). *In*: С.А. Васильев and Л.В. Кулаковская, eds. *С.Н. Бибиков и первобытная археология*. Санкт-Петербург: ИИМК РАН, 306–316.

Iakubenko 2011: Якубенко, О.О., 2011. Антропоморфна пластика трипільського поселення Володимирівка. *In*: Ю. Олійник, ed. Тематичний збірник наукових праць (20 років Незалежності України). Київ: Національний музей історії України, Такі справи (2010), 56–80.

Kiosak *et al.* 2014: Кіосак, Д.В., Денисюк, В.Л. and Поліщук, Л.Ю., 2014. Орнітоморфне брязкальце трипільської культури з півночі Одещини. Археологія, 2014 (3), 67–72. Available from: http://dspace.nbuv.gov.ua/bitstream/handle/123456789/195696/08-Kiosak.pdf?sequence=1

Kosakivskyi 1993: Косаківський, В.А., 1993. Пізньотрипільське поселення Чечельник на Побужжі. *In*: В.А. Косаківський, ed. Подільська старовина: збірник наукових праць. Вінниця: Вінницький обласний краєзнавчий музей, 97–108.

Kosakivskyi and Rud 2009: Косаківський, В.А. and Рудь, В.С., 2009. Дослідження житла трипільської культури на поселенні в с. Буша. *In*: С.А. Васильев and Л.В. Кулаковская, eds. *С.Н. Бибиков и первобытная археология*. Санкт-Петербург: ИИМК РАН, 336–343.

Kosakivskyi and Rud 2010: Косаківський, В.А. and Рудь, В.С., 2010. Археологія Буші та її околиць. Археологія і Давня історія України, 4, 180–189. Available from: http://dspace.nbuv.gov.ua/bitstream/handle/123456789/161403/22-Kosakivskyi.pdf?sequence=1

Makarenko 1926: Макаренко, М.О., 1926. Етюди з обсягу трипільської культури. *In*: В. Козловська and П. Курінний, eds. *Трипільська культура на Україні* / *La culture de Tripolie en Ukraine*, Vol. 1. Київ: Українська академія наук, 165–186.

Monah, D., 2012. *Plastica antropomorfă a culturii Cucuteni-Tripolie*. Bibliotheca Memoriae Antiquitatis XXVII. Piatra-Neamț: Editura "Constantin Matasă".

Ovchynnykov 2014: Овчинников, Е.В., 2014. Трипільська культура Канівського Подніпров'я. Київ: Видавець Олег Філюк.

Patokova *et al.* 1989: Патокова, Э.Ф., Петренко, В.Г., Бурдо, Н.Б. and Полищук, Л.Ю., 1989. Памятники трипольской культуры в Северо–Западном Причерноморье. Киев: Издательство «Наукова думка».

Pogoševa 1983: Погожева, А.П., 1983. *Антропоморфная пластика Триполья*. Новосибирск: Наука.

Pogoševa, A.P., 1985. Die Statuetten der Tripolje-Kultur. *Beitrage zur allgemeinen und vergleichenden Archäologie*, 7, 95–242.

Polishchuk 1986: Полищук, Л.Ю., 1986. Пластика трипольского поселения Черкасов Сад II. *In*: Г.А. Дзис-Райко, И.Б. Клейман, Э.Ф. Патокова, Л.Ю. Полищук and Н.М. Секерская, *Памятники древнего искусства Северо-Западного Причерноморья*. Киев: Издательство «Наукова думка», 21–26.

Rud 2018a: Рудь, В.С., 2018a. *Трипільська культура півдня лісостепової зони у межиріччі Південного Бугу та Дністра (етапи ВІІ – СІ)*. [PhD thesis. Національна Академія Наук України]. Available from: https://shron1.chtyvo.org.ua/Rud_Vitalii/Trypilska_kultura_pivdnia_lisostepovoi_zony_u_mezhyrichchi_Pivdennoho_Buhu_ta_Dnistra_etapy_VIISI.pdf

Rud 2018b: Рудь, В.С., 2018b. *Трипільська культура півдня лісостепової зони у межиріччі Південного Бугу та Дністра (етапи ВІІ – СІ)*. Автореферат дисертації к. і. н. [Summary of the PhD thesis. Національна Академія Наук України].

Rud *et al.* 2018c: Рудь, В., Улрау, Р., Федоров, С. and Зайцева, О., 2018. Дослідження на поселеннях Трипільської культури Тростянчик та Війтівка. Археологічні дослідження в Україні, 2016, 11–14.

Rud, V., Hofmann, R., Kosakivskyi, V., Zaitseva, O. and Müller, J., 2019a. Trypillia Megasites West of the River Southern Buh: Preliminary Results of Bilyi Kamin Site Investigation in 2018. *Journal of Neolithic Archaeology*, 21, 27–60. Available from: DOI: 10.12766/jna.2019.2

Rud, V., Zaitseva, O., Hofmann, R., Rauba-Bukowska, A. and Kosakivsky, V., 2019b. Unique Pottery Kiln Construction? The Interpretation of Massive Clay Objects from the Trostianchyk Site of the Trypillia Culture. *Sprawozdania archeologiczne*, 71, 11–39. Available from: DOI: 10.23858/sa71.2019.001

Rud *et al.* 2019c: Рудь, В., Хофманн, Р., Косаківський, В., Зайцева, О. and Мюллер, Й., 2019. Білий Камінь: планування найбільшого поселення трипільської культури межиріччя Південного Бугу та Дністра. Археологія та давня історія України, 4 (33), 362–372. Available from: http://dspace.nbuv.gov.ua/bitstream/handle/123456789/167215/32-Rud.pdf?sequence=1

Rud *et al.* 2021: Рудь, В., Хофманн, Р. and Косаківський, В., 2021. Магнітні аномалії лінійного характеру на поселеннях Трипілля ВІІ Тростянчик та Ворошилівка. *In*: A. Diachenko, T.K. Harper, Y. Rassamakin and I. Sobkowiak-Tabaka, eds. *Data Systematization in the Neo-Eneolithic of Southeastern and Central Europe. Essays in honor of Sergej Ryzhov* / Систематизація неолітичних *і* енеолітичних матеріалів Південно-Східної та Центральної Європи*.* Збірка наукових праць на пошану Сергія Рижова. Kyiv: Institute of Archaeology of the National Academy of Sciences of Ukraine, 246–264.

Sorokin, V., 2001. Plastica antropomorfă din aşezarea cucuteniană dela Brânzeni VIII, jud. Edineţ. *Memoria Antiquitatis*, 22, 137–155.

Sorokin, V., 2004. Aşezările cucuteni ene de tip Solonceni. *Memoria Antiquitatis*, 23, 167–202.

Sorokin, V. and Borziac, I., 2001. Plastica antropomorfă a aşezării cucuteniene Iablona I, jud. Bălţi. *Memoria Antiquitatis*, 22, 115–136.

Țerna, S. and Vasilache, M., 2019. *Figurinele antropomorfe din etapa Cucuteni A din interfluviul pruto-nistrean (*în *baza colecţiilor Muzeului Naţional de Istorie a Moldovei)* / *Anthropomorphic figurines from Cucuteni A stage from the Prut-Dniester interfluve (the collections of the National Museum of History of Moldova)*. Bibliotheca «Tyragetia» 31. Chișinău: Muzeul Naţional de Istorie a Moldovei.

Uhl, R., 2018. Von Tonstiften und Tokens. Betrachtung einer enigmatischen Objektgruppe im Nordpontus. *Revista Arheologică*, XIV (2), 5–12.

Videiko 2004: Відейко, М.Ю., 2004. Об'ємні глиняні символи трипільської культури. *In*: М.Ю. Відейко and Н.Б. Бурдо, eds. Енциклопедія Трипільської Цивілізації, Vol. 1. Київ: Укрполіграфмедіа, 469–471. Available from: https://archive.org/details/trypillia

Zaiets 2001: Заєць, І.І., 2001. *Трипільська культура на Поділлі*. Вінниця: Тезис.

Zaiets and Ryzhov 1992: Заец, И.И. and Рыжов, С.Н., 1992. Поселение трипольской культуры Клищев на Южном Буге. Киев.

PRUT-DNIESTER INTERFLUVE (REGION C)

16. Pits as durable narratives – Results of the 2019 excavation campaign in the Trypillia settlement Stolniceni 1, Moldova

Stanislav Țerna†, Andreea Țerna, Robert Hofmann, Mariana Vasilache, Marta Dal Corso, Yevhenii Sliesariev, Wiebke Kirleis, Johannes Müller

Abstract

During the 2019 excavation campaign at the medium-sized (30 ha) Copper Age settlement of Stolniceni in Northern Moldova, we applied an approach in which pits of different categories of houses and communal buildings identified in the plan of the magnetic survey were systematically tested regarding their significance for determining the socio-economic structure of a Trypillia B2/C1 community. In contrast to inventories of houses, which tend to represent snapshots related to the final phases of household life, possibly biased by processes of abandonment, associated pits rather represent entire biographies of households and therefore enable a much more reliable reconstruction of social differences. Based on systematic comparisons of stratigraphy and find inventories from four pits within a neighbourhood in Stolniceni, we are able to identify structural similarities between these durable pit archives and to link them to the biographies of nearby located houses. In conjunction with the plan of the magnetic survey, the identified inventory differences promise a more detailed socio-economic differentiation of the settlement in the future.

Introduction: Spatial organisation of mega-sites

In recent years, considerable efforts of scholars from various countries have been oriented towards the deciphering of the socio-economic organisation of the so-called mega-sites of the Chalcolithic Cucuteni-Trypillia culture. Thus, for the Ukrainian mega-site of Maidanetske, it has been postulated that the settlement was organised in the following units: a household (= dwelling with adjacent pits and immediate space around it), a neighbourhood (5–10 houses within a house-row, and probably including nearby houses from neighbouring rows), a quarter (50–150 households associated with an integrative facility such as a mega-structure, cf. Hofmann *et al.* 2019) and the mega-site itself with all of its 2300 households (Müller *et al.* 2016; Müller *et al.* 2018). At the same time, the social structure of the site would include lineages and supra-household economic units. A similar site organisation, although interpreted in a completely different way, has been proposed for Nebelivka (Gaydarska *et al.* 2019) with several scales: household (*e.g.* burnt house), neighbourhood (up to 27 houses, in most cases 3 to 7 houses) and quarter (comprising more than ten neighbourhoods associated with an assembly house).

In principle, the quarters defined at both Nebelivka and Maidanetske stretch across several concentric house-rows in a kind of radial 'pie-like' structure. A generally similar organisation, although at a completely different scale, has been recorded for smaller, 30 ha area sites in Moldova (a potentially formative region for the mega-site phenomenon, cf. Țerna *et al.* 2018). At the same time, these settlements display some remarkable differences from the Ukrainian examples. Thus, the geophysical survey of the Petreni settlement (Rassmann *et al.* 2016) allowed the identification of ca. 26 radial house-groups, both inside and outside a ring-shaped corridor. A main mega-structure is located at the entrance to the settlement's central plaza while several other mega-structures are situated in the circular corridor. Just as in Ukrainian mega-sites, the houses display a two-fold orientation, with some oriented radially towards the settlement's centre and others positioned tangentially.

A generally similar layout has been recorded for the settlement of Stolniceni in the Prut river basin of Northern Moldova. Here, ca. 27 house-groups were identified. As at Petreni, they are situated both inside and outside the corridor. The ones inside the corridor (= on the perimeter of the central empty space) consist mainly of radially oriented houses. The ones outside the corridor (making up the outer area of the settlement) have a more complex layout. Despite certain variations in size and number of dwellings, each outer house-group displays the same structural elements, namely (Fig. 1):

1. A row of radial dwellings oriented towards the central plaza and facing the circular corridor. The houses in this row are larger than the rest of the houses in the house-group. Usually, one of these houses is larger than the others and may be referred to as the 'α-house' while the rest can be termed as 'β-houses'
2. Two parallel or slightly divergent rows comprising tangentially oriented dwellings. These are located in the space between the row of radial houses and the settlement's outer limit (marked by a palisade and ditches). Generally, these houses are smaller in size and may be designated as 'γ-houses'. They are more numerous than 'α-' or 'β-houses';
3. A trapezoidal empty space ('courtyard') delimited by the three house-rows (one radial and two tangential) and the palisade. In some of the house-groups, this space contained pottery firing kilns and further associated features;
4. Pits of different size, usually connected to houses. The quantity of pits in some of the house-groups outnumbers the number of dwellings;

5. Circular anomalies which are, *sensu stricto*, not located in the territory of the house-groups but are arranged peripherally around the settlement, outside its limits, in such a way that each such anomaly corresponds to an outer house-group. Therefore, we can link them to these house-groups as a characteristic structural element. These anomalies represent round agglomerations of fragmentary finds (pottery, animal bones, tools and miniatures) concentrated on an area with light-greyish soil. An assembly function may be presumed for these features.

In principle, from a structural point of view, the radial 'pie-like' house-groups at Stolniceni and Petreni correspond to the quarters at Maidanetske and Nebelivka. Therefore, an understanding of such house-groups in Moldovan large settlements may offer further insight into the interpretation of the much larger quarters at Ukrainian mega-sites. Stolniceni represents a perfect candidate for such work since it has a very clear structure and does not display any overlapping features as is the case of Petreni, where some of the houses are located above an inner, older ditch.

Pits as durable narratives

Traditionally, Cucuteni-Trypillia archaeological research has been focused on houses. For several decades, this approach was driven by a combination of both subjective and objective reasons. The impressive architectural remains concealing beautiful ornamented pottery as well as the astonishing radial geometry of house locations led researchers to prefer a house-oriented digging strategy. In the decades before the implementation of geophysical non-invasive methods, initial settlement plans of complex sites were drawn up based on systematic searches for burnt dwellings and their complete excavation, or plotting onto a spatial plan (Passek and Krichevsky 1946; Passek 1949). Furthermore, when the first geophysical surveys began, the resolution of the equipment available in the 1970s–1980s mainly allowed the identification of only anomalies with high nT intensity, such as burnt houses

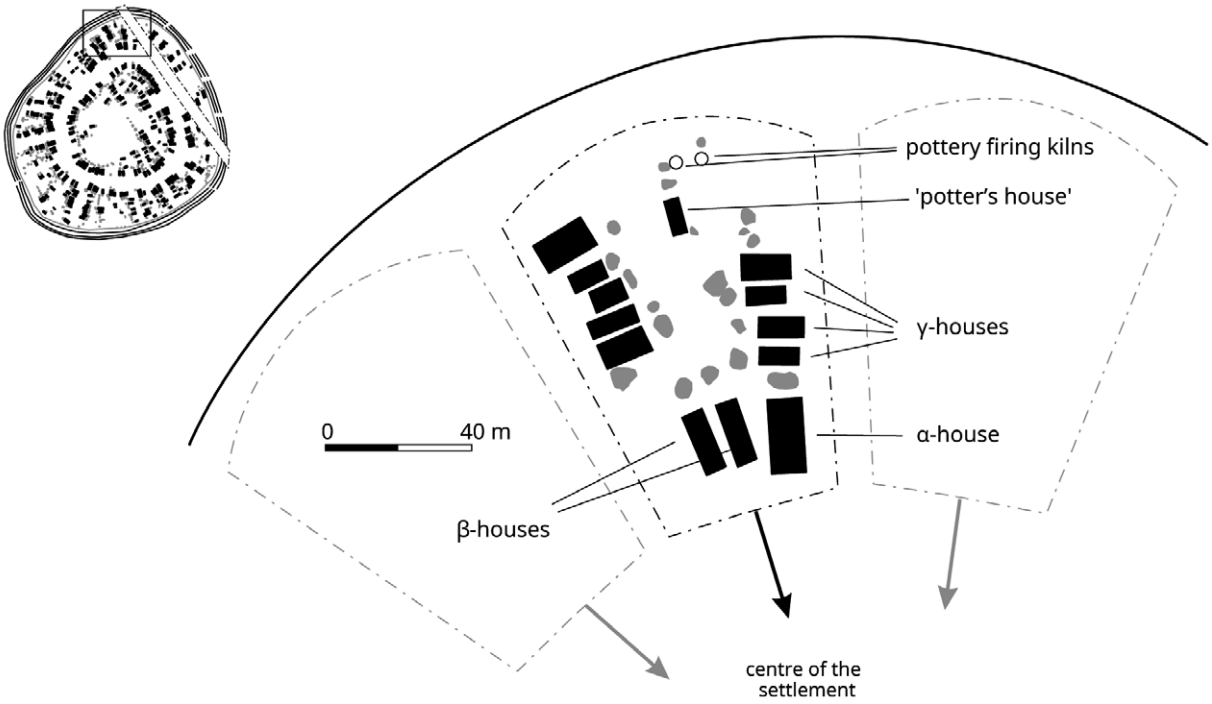


Figure 1. Structural plan of the northern house-group at Stolniceni (graphic: S. Țerna).

(Dudkin and Videiko 2009; Țerna 2016; Videiko and Rassmann 2016). Because of this, the benefits of geophysical surveys were used solely for the investigation of dwellings. Naturally, in excavation trenches pits would often occur, either under the burnt house or in its immediate vicinity and many of these pits have been excavated completely. However, a pit-oriented excavation approach has not been possible until recent times.

Results of older excavations at Moldovan mega-sites, such as the Trypillia B2 site at Brînzeni VIII (Țerna 2021), revealed particular variations in the inventory of pits related to above-ground houses of different size. Thus, most of the finds associated with prestige consumption and display were associated with the pit near an oversized house (probably corresponding to a β-house at Stolniceni). In general, the Brînzeni case has shown that the quantity and spectrum of finds which may be considered relevant for socio-economic comparative studies performed on households from the same or distinct house-groups, is quite high in the pits, not only in the above-ground houses. A 'house+pit' combination is considered to be definitory for a mega-site household as a socio-economic unit (Müller *et al.* 2016). Pits therefore should reflect the activities of the respective houses. Since most of the Cucuteni-Trypillia houses were deliberately burnt, the finds kept in a dwelling at the time of its burning may in contrast not necessarily correspond to its usual 'living' inventory. One could suppose that the preparation of the 'setting' or the 'scene' for such a socially, ritually and visually influential event as the burning of a dwelling, a house-group or even an entire settlement would imply a selection of artefacts being placed into houses intended to be burnt. Hence, we do not know to what extent such a possible selection corresponded to the activities performed during the 'life' of a household.

In the light of the variations in household inventory recorded at Brînzeni and the implications for studying the socio-economic structure of mega-sites, a systematic excavation of pits associated with houses of various sizes may be crucial. Pits seem to be the correct type of archive that may potentially provide answers to very important questions regarding consumption, production, specialisation and the hierarchy of households. A thorough investigation of the refill layers, including the package of ashy layers which is typical for Cucuteni-Trypillia mega-sites, can offer valuable insights into plant and animal economy as well as permanence of occupation. Finally, stratigraphical contexts observed in pits should provide a good background for Bayesian modelling of ^{14}C dates.



Figure 2. Aerial view from the east over the settlement and the three trenches excavated in 2019 (photo: S. Țerna).

To conclude, an above-ground house is a relatively rapid snapshot of human activities at a Trypillian settlement, just before it was burnt down. We do not know to what extent this snapshot is relevant for the estimation of the socio-economic role and setting of a household. In contrast, a pit is a durable narrative which can – and should – be researched systematically. Comparative analysis of pit inventories and biographies has the potential to represent a major empirical background for understanding the complex Cucuteni-Trypillia large and mega-sites.

Strategy and methodology

In order to check possible variations in pit inventories and their implications for understanding the socio-economic role of the respective above-ground houses from Stolniceni, in 2018 and 2019 excavation trenches were opened on four pit anomalies, each of them corresponding to buildings of various positions and sizes[1]. Three of the trenches were focused on pits from α-, β- and γ-houses while the fourth one investigated the pit from one of the two mega-structures (Figs. 2–4). It was decided that the first three trenches (№ 16, 19 and 20) should be placed on pits from the northernmost house-group of the settlement where, in previous years, a pottery-firing complex was discovered (Țerna *et al.* 2017; Țerna *et al.* 2019). Moreover, the respective α- and β-houses had been already included in a 2017 test trench (№ 13) which provided pottery finds, absolute datings and information about the architecture of both dwellings (Țerna *et al.* 2019, 256–258), thus offering data for dwelling-pit comparison. The fourth trench (№ 21) was opened on the large pit corresponding to the northern, larger mega-structure.

For all four trenches, the same methodology was used (this applied also in previous years, for example during excavation of the pit near the 'potter's house' from Trench 7 – see Țerna *et al.* 2019, 242–243). The excavation of each pit was carried out in 1×1 m raster on 20 cm spits. The upper 80–100 cm were removed on the entire area of the trench. Subsequently, after clearly contouring the pit borders, the excavated area was gradually reduced in order to leave the natural clay untouched and remove just the refill of the dug-out features; thus, our approach represented a combination of both artificial and natural excavation layers.

After removing the black arable topsoil (the first two spits or ca. 40 cm), we left cross-like profiles on each trench. These had widths of 50 cm so that they would remain stable even if the depth of the pits reached considerable values. These profiles served as the main sources both for understanding the stratigraphy and for the collection of various samples from distinct refill events of a pit. After the pits were excavated down to sterile soil, the profiles were documented and subsequently removed; therefore, all of the pits have been almost entirely excavated.

All of the soil resulting from the four trenches was sieved (mesh size 1×1 and 1.5×1 cm). The exact positions of the small finds, vessel profiles, ochre and charcoal remains were measured using Leica tachymeters and an Emlid Reach DGPS. Drawings of both excavation plana and profiles were made from 2D and 3D photogrammetry combined with field sketches, observations and notes. The field photos were taken with handheld DSLR-cameras and UAVs (DJI Phantom III and Mavic Pro 2, the latter equipped with a high resolution 20 Megapixel Hasselblad camera).

For each planum, magnetic susceptibility measurements were recorded on a grid. As regards natural sciences data, macrobotanical samples (10 l volume) were taken regularly from each excavation spit, while phytolith and geo-archaeological sequences were recorded both on the trench walls and on the inner cross-like profiles through the pits.

1 The pit from the β-house was excavated in 2018 (Trench 16) while the pits from α-, γ-dwellings and the mega-structure were excavated in 2019 (Trenches 19, 20 and 21).

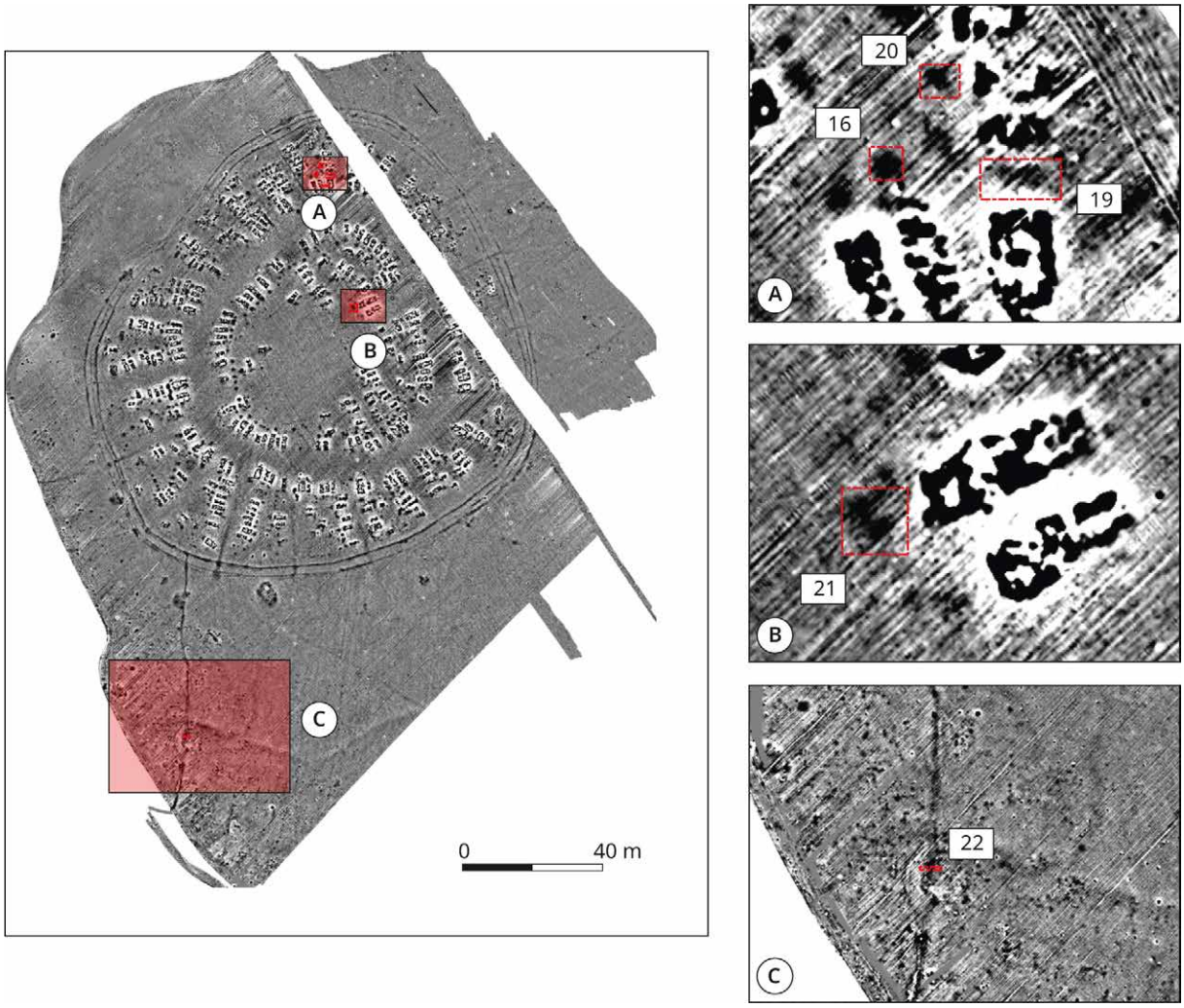


Figure 3 (above). Trenches 16 and 19–22 on the geophysical plot of the settlement (graphic: K. Rassmann, S. Țerna).



Figure 4. Trenches 19 and 20 (foreground) and 21 (background) seen from the north (photo: J. Müller).

Systematic investigation of pits

Trench 16

The trench was oriented in cardinal directions, had an area of 25 m² (5×5 m) and was opened over the pit anomaly located by the northwestern short wall of the β-house. The southern border of the anomaly was situated at a distance of ca. 6.3 m from the wall of the building.

Description of features on plana (Fig. 6)

The dug-out feature first appeared on Planum 3A (depth ca. 60 cm) as a round darker spot spread over almost the entire trench area (Feature 16003, area 15 m²) and partly continuing under the eastern trench wall. Close to the borders of this feature, several find agglomerations of a 'funnel-like' layout were cleaned. These were subsequently traced as far as Planum 3B (depth 85–90 cm) which revealed that the massive and compact deposition of pottery fragments, animal bones, daub, stones, tools and miniatures (Fig. 5) was concentrated mainly in the eastern half of the pit (Feature 16005) over an area of at least 12 m² in Excavation Quadrats C–E/1–5.

This agglomeration continued, although displaying a lower density of finds, on Planum 4 (depth 110 cm). The pit contour here had a rounded-oval shape. Further down, on Plana 5–6, the dug-out feature preserved the same configuration, with the same area of about 15 m². Starting from a depth of ca. 170 cm, the pit reduced mainly to the central-eastern part of the trench, becoming gradually smaller towards the bottom (8 m² on Planum 7, 6 m² on Planum 8, 4 m² on Planum 9 and ca. 1 m² on Planum 10). The latter was reached at a depth of about 260 cm below the modern-day surface or ca. 200 cm below the prehistoric step-surface.



Figure 5. Massive 'funnel-like' discard of waste in the upper part of the pit at Trench 16 (photo: J. Liebscher).

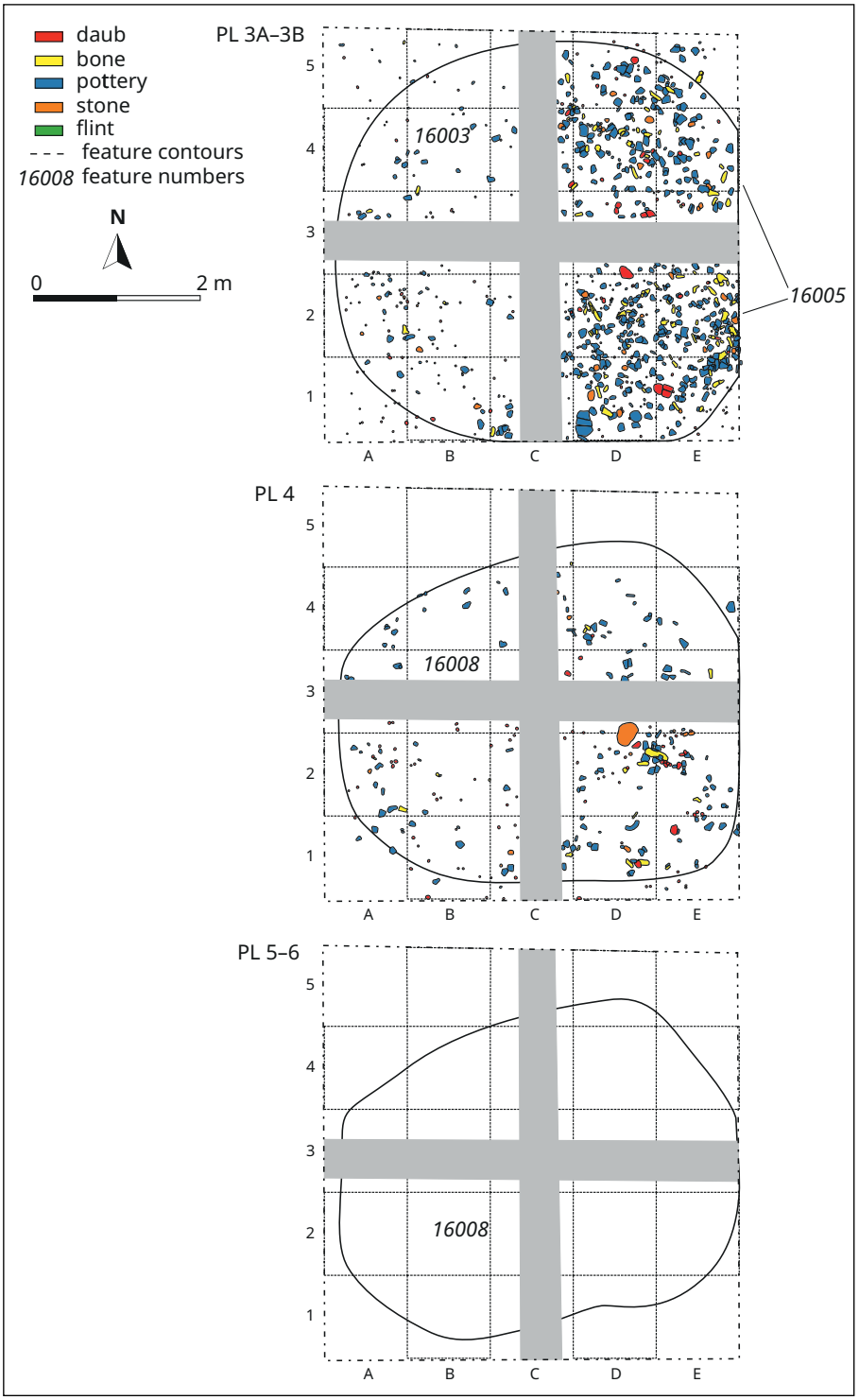


Figure 6. Trench 16, Excavation Plana 3–6 (graphic: S. Țerna).

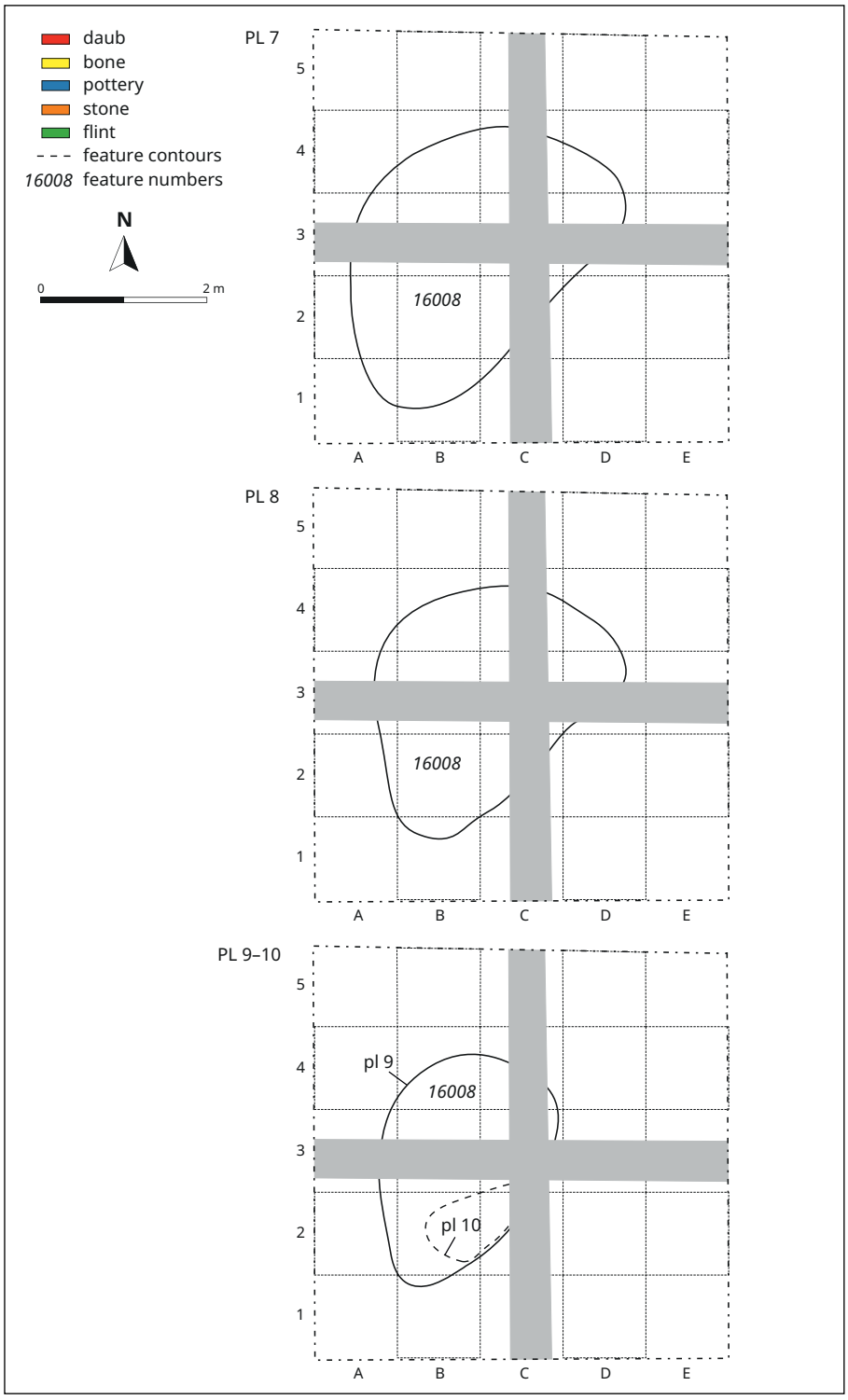


Figure 6 (continuation). Trench 16, Excavation Plana 7–10 (graphic: S. Ţerna).

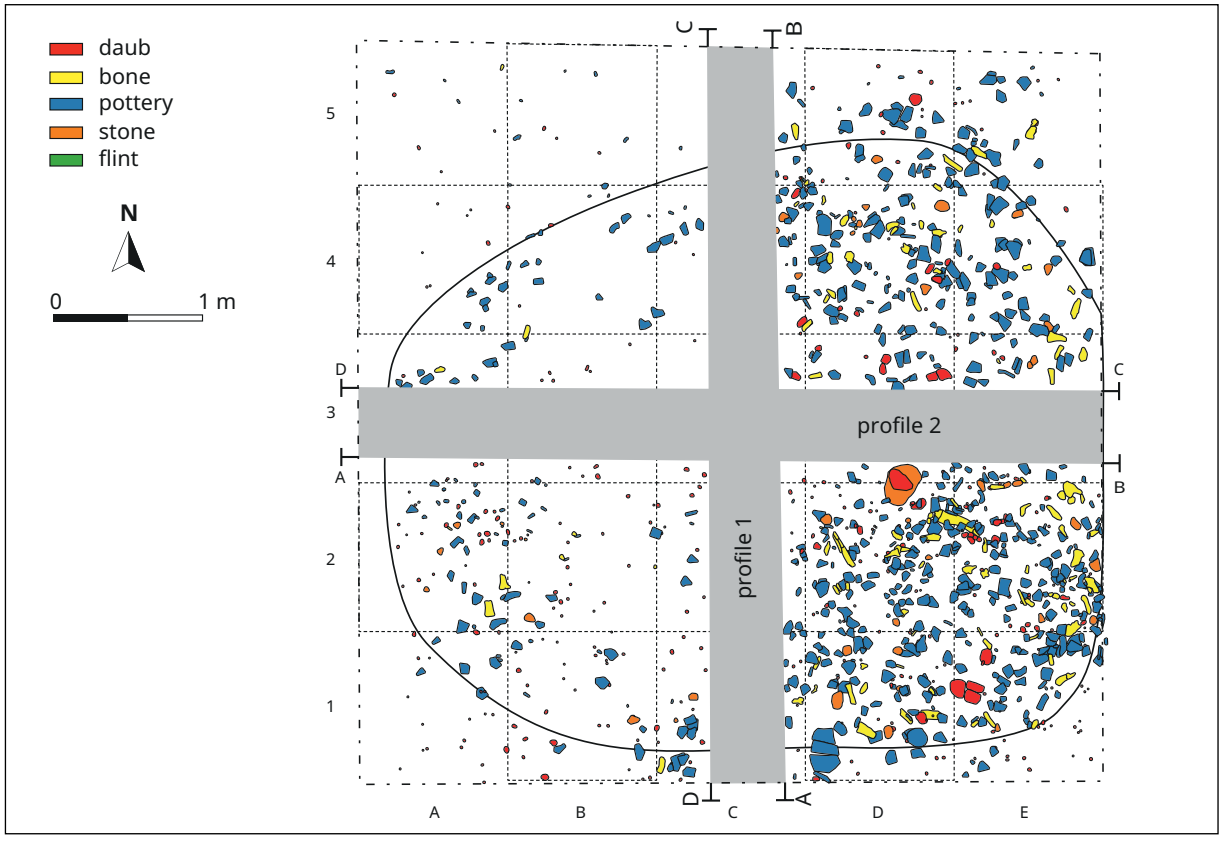


Figure 7. Trench 16, combined excavation plana (graphic: S. Țerna).

Stratigraphy

The following layers were recorded in the cross-profiles (described downwards; Figs. 8, 9):

1. Black arable and unploughed soil with little archaeological material (thickness 40 cm);
2. Dark grey-brown compact silt with abundant quantity of tiny daub pieces and small shards (thickness 52–94 cm);
3. Lighter grey-brown compact silt with a compact deposition of large pottery fragments, bones, daub and a few stones (thickness 2–30 cm);
4. Grey-light-brown moderately compact silt with thin ashy layers and spots of charcoal; contained dispersed pottery fragments and daub (thickness 3–53 cm);
5. Grey-light-brown moderately compact silt with a compact thin deposition of small daub fragments (thickness 2–7 cm);
6. Dark-brown compact silt with thin ashy layers and charcoal spots; a small amount of finds (thickness 12–50 cm);
7. Light-yellow-brown clayish compact layer with almost no finds (collapsed wall of the pit; thickness 4–29 cm);
8. Dark-brown compact silt with thin ashy layers and charcoal spots; contained large pottery fragments, daub and massive animal bones (thickness 3–30 cm);
9. Dark-brown compact clayish sediment with almost no finds (thickness 6–13 cm);
10. Light-yellow-brown clayish compact layer with some charcoal spots and a small amount of finds (thickness 3–19 cm);
11. Dark-brown compact clayish sediment with almost no finds (thickness 3–15 cm).

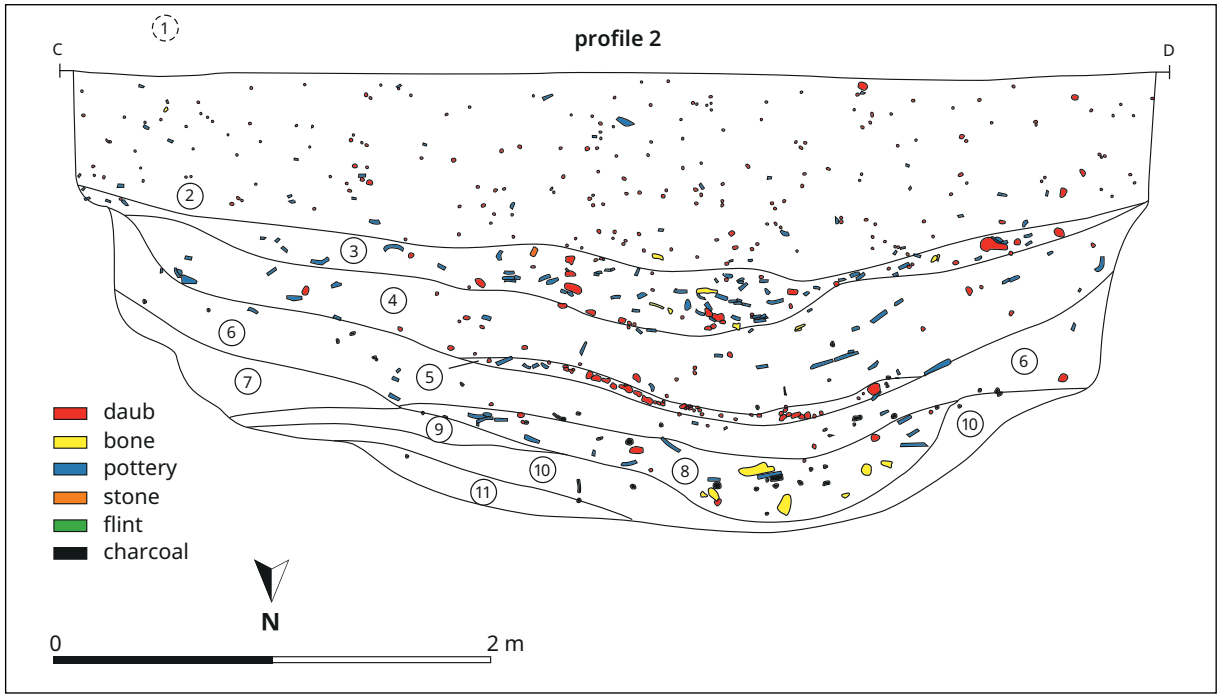


Figure 8 (above). Trench 16, Profile 2 C–D. Numbering of layers corresponds to those in the text (graphic: S. Ţerna).



Figure 9. Trench 16, photo of Profile 2 C–D (photo: J. Liebscher).

Interpretation

For the dug-out features unearthed in Trench 16, we may reconstruct the following succession of chronological events:

1. The pit was dug in order to extract clay for the construction of the adjacent dwelling. The volume of extracted clay may be roughly estimated at 23.6 m³. The irregularity of the pit's bottom may be due to distinct extraction stages, which probably correlated with the construction phases of the above-ground building.
2. After the extraction of the clay, the pit was left open for a certain period. During this time, a 5–30 cm thick package of layers consisting of clayish sediment covered its bottom. These layers had mostly natural origin: thus, the darker layers represented pluvial sediment while yellowish ones represented the result of the collapse of not yet consolidated and insufficiently stable pit walls. The amount of finds (= discarded waste) was extremely low.
3. The next event is defined by a massive discard of waste mixed with charcoal remains in the central part of the pit.
4. This was followed by a thick (up to 58 cm) package of layers with medium amount of finds, ashes and charcoal. This event (the longest from a chronological point of view) may be connected to the activity of the nearby building and

consists of repetitive discard of household waste and ashes/charcoal resulting from heating of the house.
5. Another massive discard of waste (up to 30 cm thick) over the entire pit area marks the end of the activity of the house. The finds were mainly thrown in from the east, given the obviously higher density of waste in the eastern part of the dug-out feature.
6. After the house was burnt down, the adjacent pit was still visible as a large depression on the prehistoric step-surface. This depression was gradually filled with silt containing a large amount of tiny daub fragments and pottery shards, brought in naturally and coming from the debris of the burnt house.

Trench 19

The trench, oriented in cardinal directions, had an area of 72 m^2 (12×6 m) and was opened over the pit anomaly located by the northern short wall of the α-house. The southern border of the anomaly was situated at a distance of ca. 2.6 m from the wall of the building.

Description of features on plana (Fig. 12)

The dug-out feature first appeared on Planum 3 (depth ca. 60 cm) as a large irregular darker area spread over almost the entire trench (Feature 19005, area 60 m^2), with the exception of Quadrats A/1–6 and the north-eastern corner (Quadrats K–L/6). Within the borders of this area, several find agglomerations were documented in its south-western and northern parts. They consisted mainly of pottery, bones and some stones.

On the next planum (depth ca. 80 cm), the find agglomerations became more consistent and corresponded to the southern, western and northern periphery of the darker area. Variations in soil colour allowed the delimitation of several areas within the main dark spot. One of these, located in the central part of the trench, corresponded to the main anomaly from the geophysical plot (Feature 19006). The other three were outlined in the eastern and south-eastern parts of the trench and continued under its walls: Feature 19008 was approximately the same width as the central Feature 19006, while Features 19009 and 19010 represented two interconnected elongated darker areas in Quadrats H–L/1.

This configuration continued further, at the depth of ca. 100 cm (Planum 5). Here, the central pit (19006) had an irregular-oval contour of ca. 25 m^2, oriented on the east-west axis, in Quadrats C–I/1–5. Its western part contained an agglomeration of pottery and other finds spread over an area of approximately 6 m^2. The eastern pit (19008) was visible over an area of 9 m^2. The elongated Feature 19009 had approximately the same dimensions and shape as on the previous planum. Feature 19010 was no longer visible.

The final clear delimitation of the two main pits became possible on Planum 6 (depth ca. 120 cm). The central pit (19006) had here an oval contour with irregular outline (area 22 m^2). Its fill changed to more compact, grey-brown silt. Various finds (mainly pottery, animal bones and stones) were discarded here, mainly in the western part of the contour. The other pit (19008) presented as an irregular three-lobed structure with a central area in Quadrats KL/3–4 and two rounded areas with a diameter of ca. 1 m, adjoining the central area symmetrically from the north and the south (Quadrats L/5 and L/1–2). Each of these round features contained an agglomeration of pottery, with large animal bones and stones deposited underneath, at various depths; the northern concentration was revealed at Planum 6 and the southern one (19009) at Planum 7 (Fig. 11).



Figure 10. Waste agglomeration on the south-western part of the central pit from Trench 19, Planum 7 (photo: UFG Kiel).



Figure 11. Compact finds agglomeration at the bottom of the second pit in Trench 19 / Feature 19009 (photo: M. Vasilache).

A massive agglomeration of finds was seen in the main pit (19006) at 140 cm depth (Fig. 10). It consisted of large pottery fragments, including vessels with almost complete profiles, animal bones and stones. The finds, while discarded across the entire area of the feature (18 m^2), were found in two concentrations, in the western and eastern parts of the pit.

The central Pit 19006 remained the only feature of the trench starting with Planum 8. From here and as far down as Planum 10, it had the same irregular-oval configuration over an area of 12 m^2. The quantity of finds in the agglomerations gradually decreased, so whereas on Planum 8 they were still covering most of the feature contour, on Planum 9 they reduced to the eastern part of the pit and disappeared completely on Planum 10. At ca. 200 cm depth, the fill changed to brown and light-brown medium compact clayish sediment with large irregular ashy spots.

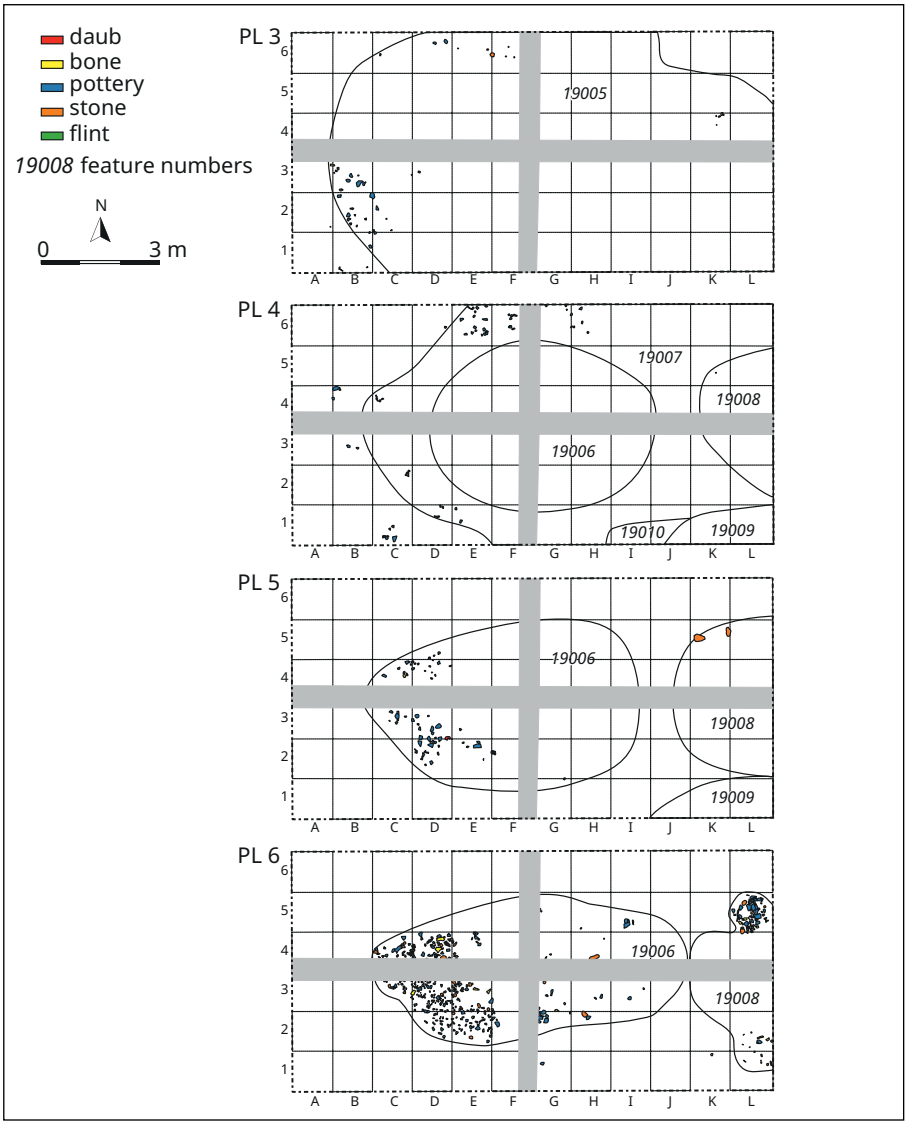


Figure 12A. Trench 19, Excavation Plana 3–6 (graphic: S. Ţerna).

Starting at Planum 11 (ca. 220 cm depth), the pit contour changed, becoming narrower and displaying two components: an elongated-oval one in Quadrats C–G/3–4 and an irregular-roundish one in Quadrats G–I/2–3. This outline, with a total area of 8 m^2, continued to the bottom of the pit, which was reached on Planum 13 or at a depth of ca. 260 cm. Several large spots of burnt sediment were encountered here, lying just above the sterile soil.

The bottom of the pit was irregular and consisted of two deepened areas.

Stratigraphy

The following layers were recorded in the cross-profiles (described downwards; Figs. 14–16):

1. Black arable and unploughed soil with little archaeological material (thickness 40 cm);
2. Dark grey-brown compact silt with abundant quantity of tiny daub pieces and small shards (thickness 35–100 cm);
3. Lighter grey-brown compact silt with a compact deposition of large pottery fragments, bones, daub and some stones (thickness 8–28 cm);

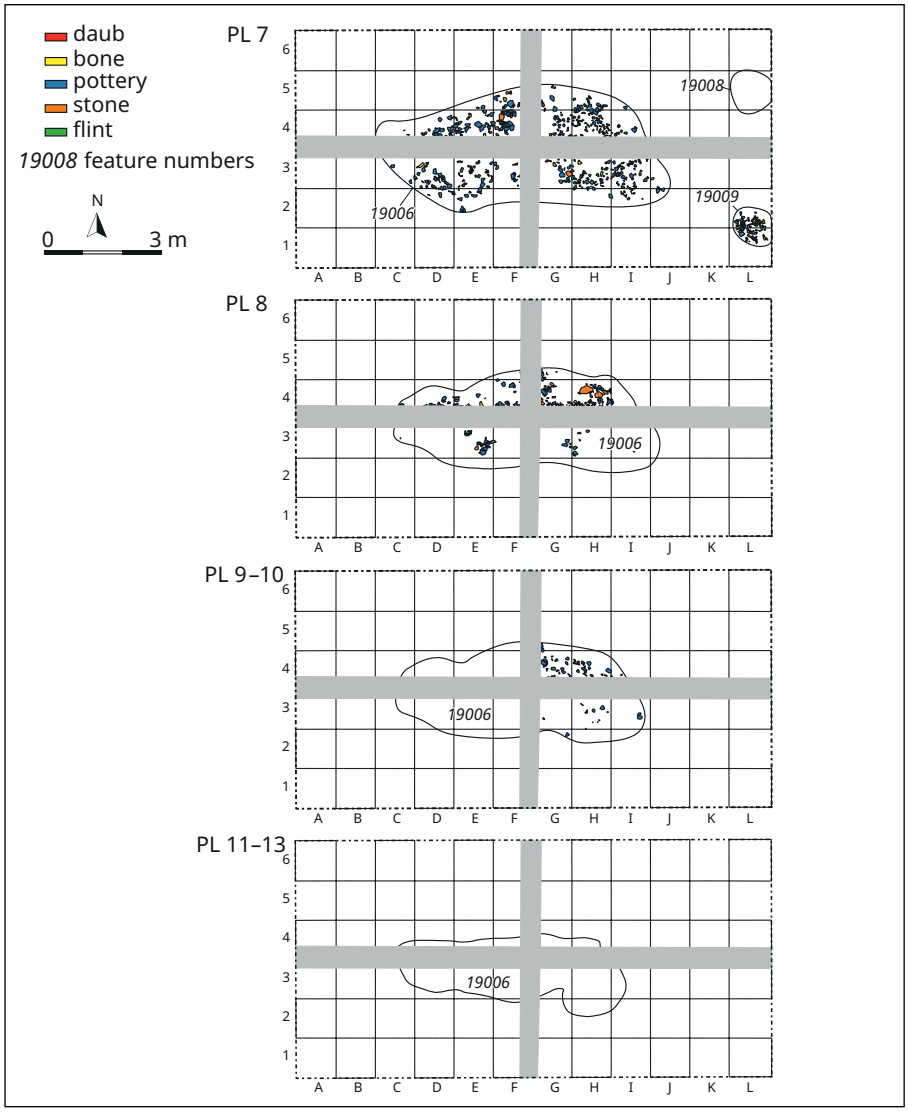


Figure 12B. Trench 19, Excavation Plana 7–13 (graphic: S. Ţerna).

4. Grey-brown compact silt with dispersed pottery fragments and daub (thickness 20–62 cm);
5. Grey-brown compact silt with sparse thin ashy layers; contained a moderately compact deposition of large pottery fragments and daub (thickness 6–14 cm);
6. Light-brown clayish layer with few finds (thickness 2–37 cm);
7. Brown medium compact clayish layer with multiple thin ashy strata, some pottery and daub (thickness 2–13 cm);
8. Light-brown/yellowish compact clayish layer with some thin ashy strata and few finds (thickness 3–21 cm);
9. Dark-brown compact layer with much continuous ashy strata and few finds (thickness 2–9 cm);
10. Dark-brown compact layer containing a stratum of burnt sediment (thickness 3–16 cm).
11. Compact yellow clayish layer in the Profile 6–4 (collapsed wall of the pit; thickness 3–23 cm);
12. Dark grey-brown compact silt with small daub pieces and medium-sized shards (Pit 19008; thickness 35–65 cm).

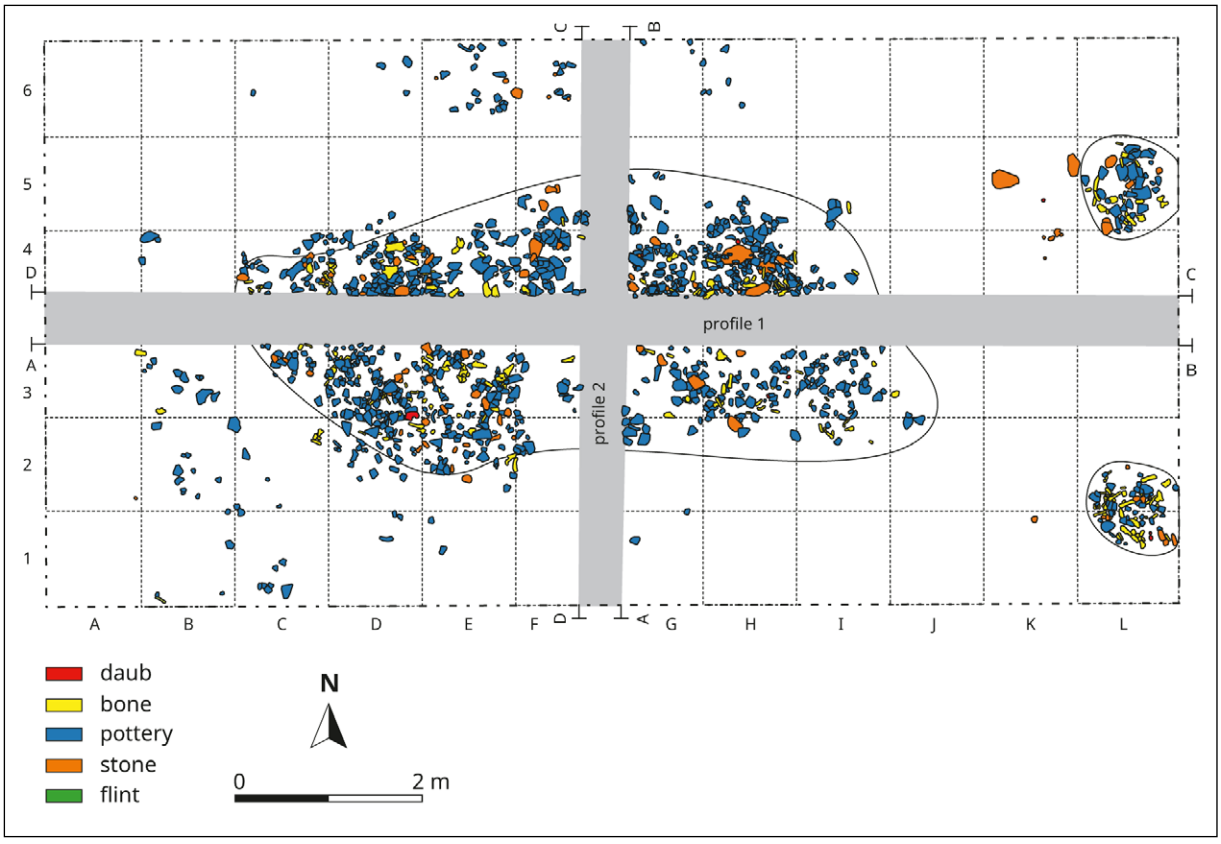


Figure 13. Trench 19, combined excavation plana (graphic: S. Țerna).

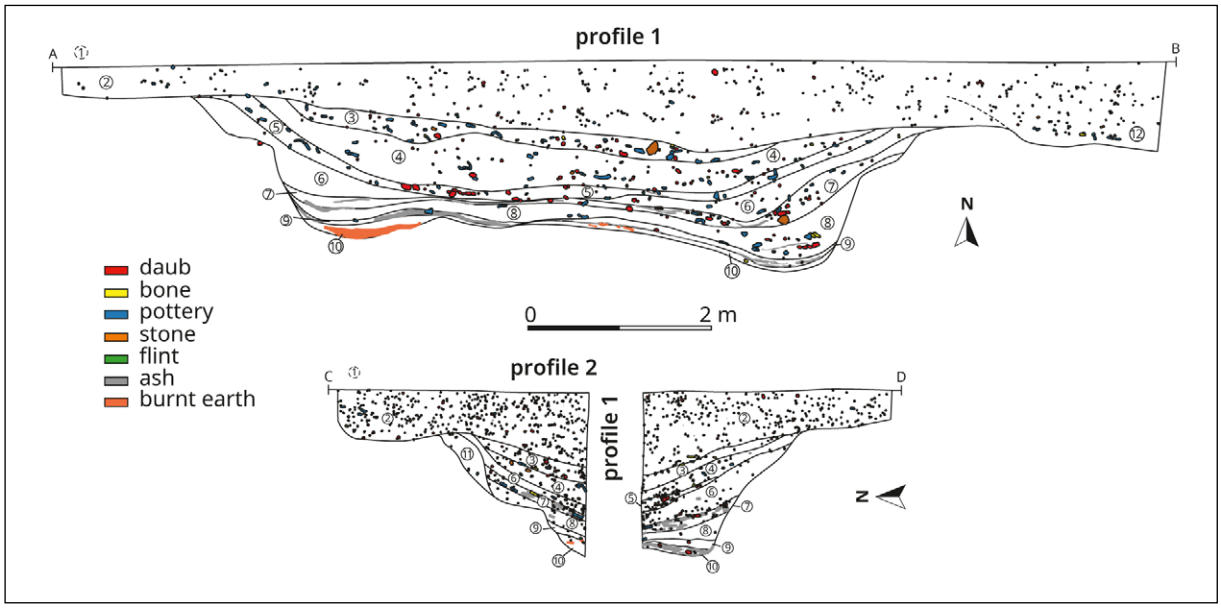


Figure 14. Trench 19, Profiles 1/A–B and 2/C–D. Numbering of layers corresponds to those in the text (graphic: S. Țerna).



Figure 15. Trench 19, photo of the main pit in Profile 1/A–B (photo: S. Ţerna).

Interpretation

For the dug-out features unearthed in Trench 19, we may reconstruct the following succession of chronological events:

1. The main pit was dug in order to extract clay for the construction of the adjacent dwelling. The volume of extracted clay may be roughly estimated at 45.8 m^3. The two depressions at the bottom of the pit may represent distinct extraction stages, which probably correlated with the construction phases of the above-ground building.
2. After the extraction of the clay, the bottom of the pit was, at least in some areas, exposed to fire as witnessed by the strata of burnt earth. The interpretation of this fire is not yet clear.
3. The pit was left open for a certain period. During this time, a 5–30 cm thick package of layers consisting of clayish sediment with many thin ashy strata covered its bottom. These layers were mostly of natural origin: thus, the darker layers represented pluvial sediment while yellowish ones represented the result of the collapse of unconsolidated and insufficiently stable pit walls. The amount of finds (= discarded waste) was generally small, except for the northern part of the pit where the quantity of pottery, daub and animal bones was greater.
4. The next event is represented by a thick package of layers with a medium amount of finds, ashes and charcoal. This event (the longest from a chronological point of view) may be connected to the activity of the nearby building and consists of repetitive discards of household waste and ashes/charcoal resulting from heating of the house.
5. Within this durable sequence bound to the 'life' of the house, two massive discard events may be discerned. Both of them are characterised by a large amount of large pottery fragments, animal bones, daub, stones, tools and miniatures. The first event took place sometime at the beginning of the activity of the house, while the second marked its end.



Figure 16. Package of layers at the bottom of the main pit in Trench 19, Profile 2/A–B (photo: S. Țerna).

6. After the house was burnt down, the adjacent pit was still visible as a large depression on the prehistoric step-surface. Over time, this depression was partly filled with silt containing high amount of tiny daub fragments and pottery shards, brought in naturally and coming from the debris of the burnt house. By the northern border of pit, however, another one was dug out, containing at the bottom two compact round depositions of pottery and animal bones. This second feature is most probably connected to an activity performed after the α-house was no more in use, presumably after it had been burnt down.

Trench 20

The trench, oriented in cardinal directions, had an area of 30 m² (6×5 m) and was opened over the pit anomaly located by the western short wall of the γ-house. The eastern border of the anomaly was situated at a distance of ca. 3.4 m from the wall of the building.

Description of features on plana (Fig. 18)

The dug-out feature first appeared on Planum 3 (depth ca. 60 cm) as a larger irregular darker area (Feature 20006, area 14 m²) located mainly in the central and western parts of the trench. Within its borders and partly extending beyond them, the planum contained a moderate quantity of finds (pottery, bones and stones) including several larger shards concentrated mostly in the western part of the pit. At Planum 4 (depth ca. 80 cm), the outline of the pit changed slightly, displaying two parts of different size, the largest one comprising the central and north-western areas of the contour. The amount of finds in the planum was still moderate; at this depth, the finds were mainly contained within the outline of the dug-out feature.

A massive deposition of archaeological material was recorded at a depth of 100 cm (Planum 5). It consisted mainly of pottery and animal bones, covering mostly the central and western pit areas (Fig. 17). Many of the shards were significant in size and were of various vessel types, from bowls to half-closed large vessels; however, no full vessel profiles were documented *in situ*. The area of the pit here reached 11 m². On Planum 6, the pit preserved the same outline and dimensions. The amount of finds from the agglomeration seen above decreased, with only a few shards recorded at this depth, mainly in the central part of the pit.

Starting from Planum 7 and down to the bottom of the pit (Planum 9), the feature gradually reduced in size from 9 to 7 m². Near the bottom, the pit's contour became more regular and rounded, especially in the western and southern parts. At ca. 150 cm depth, between Plana 7 and 8, another finds agglomeration was seen, located mainly in the south-eastern part of the trench, under the cross-like profiles. Here, a large restorable coarse vessel with barbotine surface treatment was found.



Figure 17. Compact 'funnel-like' discard of waste in the western part of the pit from Trench 20, Planum 7 (photo: J. Müller).

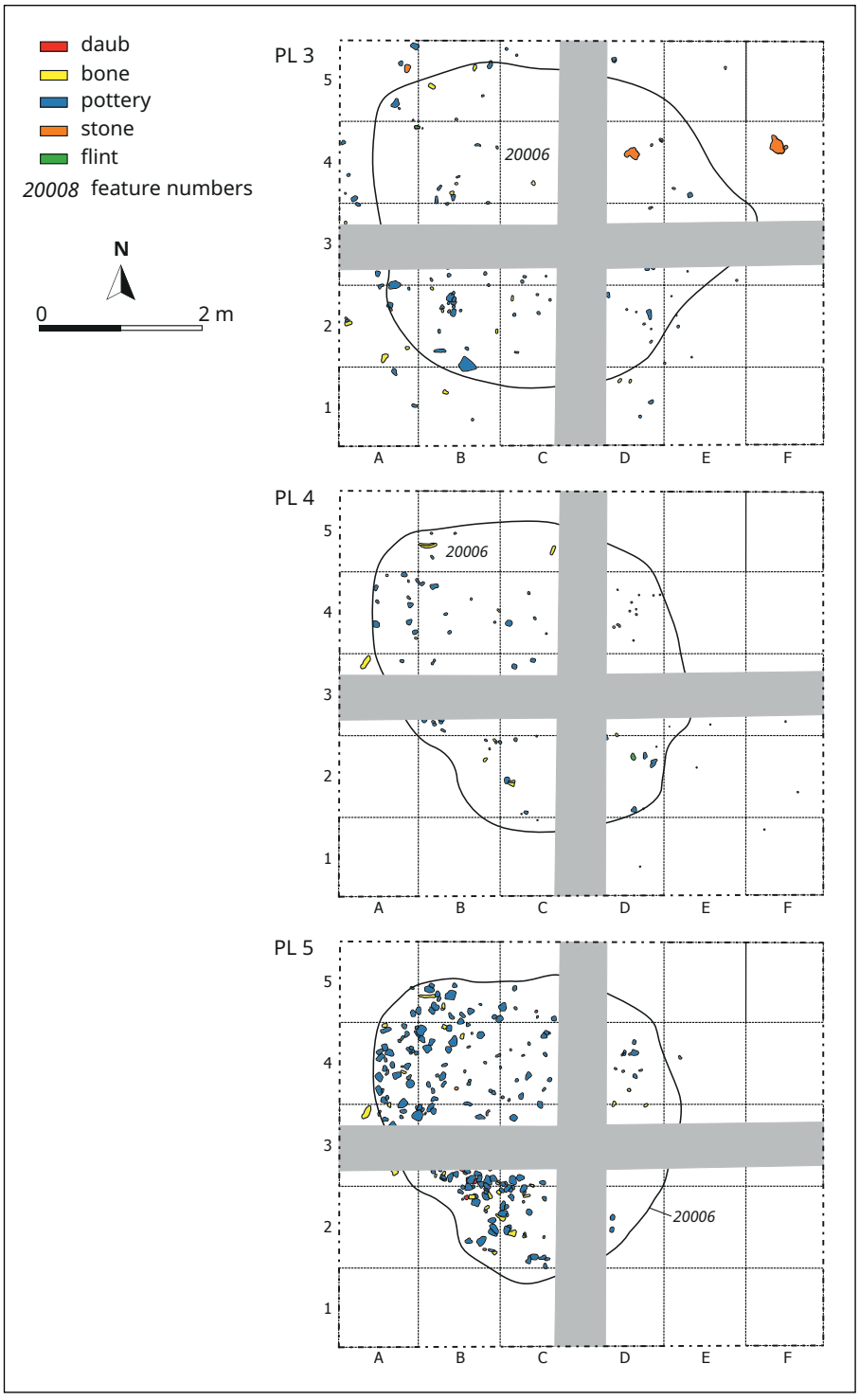


Figure 18A. Trench 20, Excavation Plana 3–5 (graphic: S. Țerna).

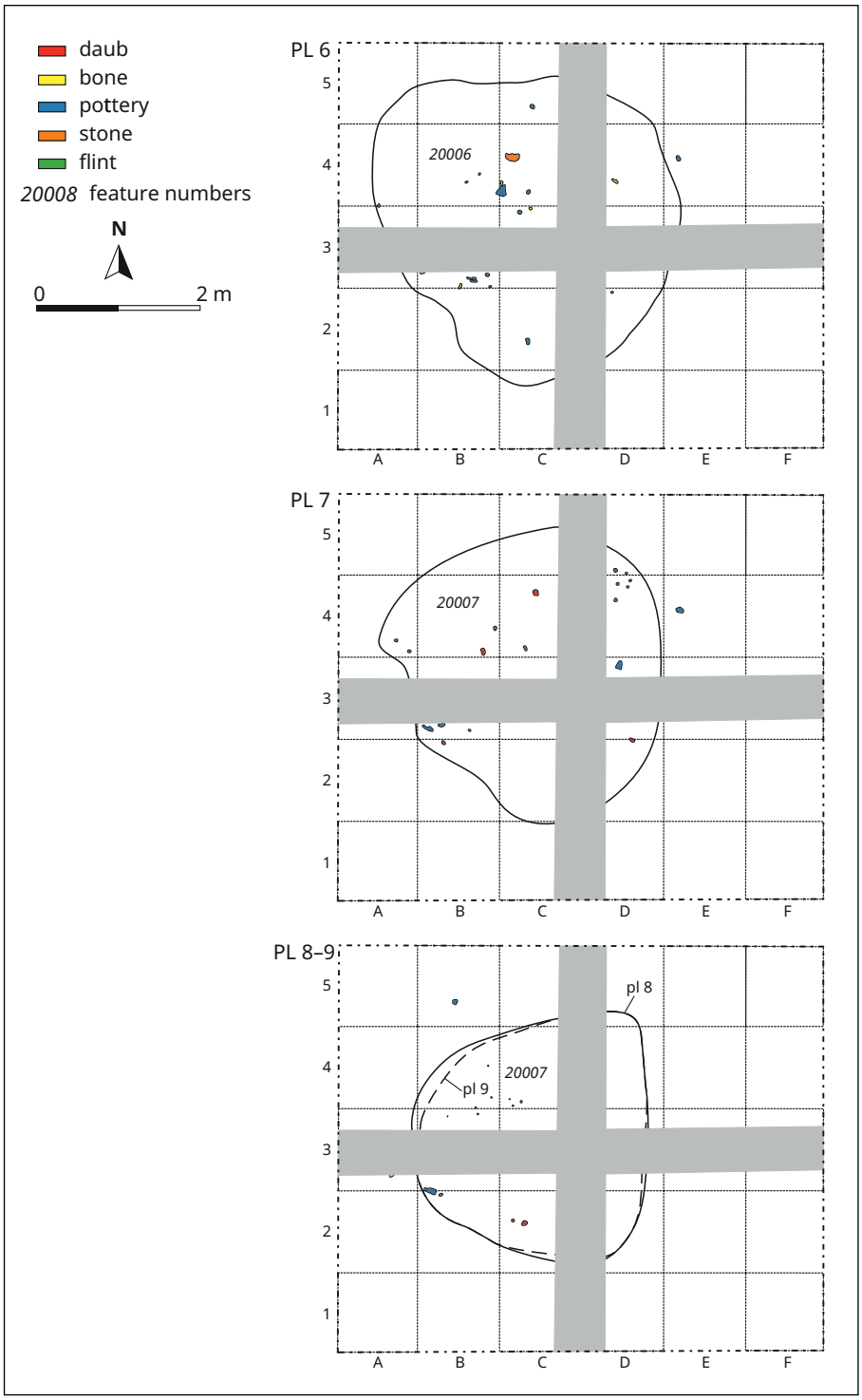


Figure 18B. Trench 20, Excavation Plana 6–9 (graphic: S. Ţerna).

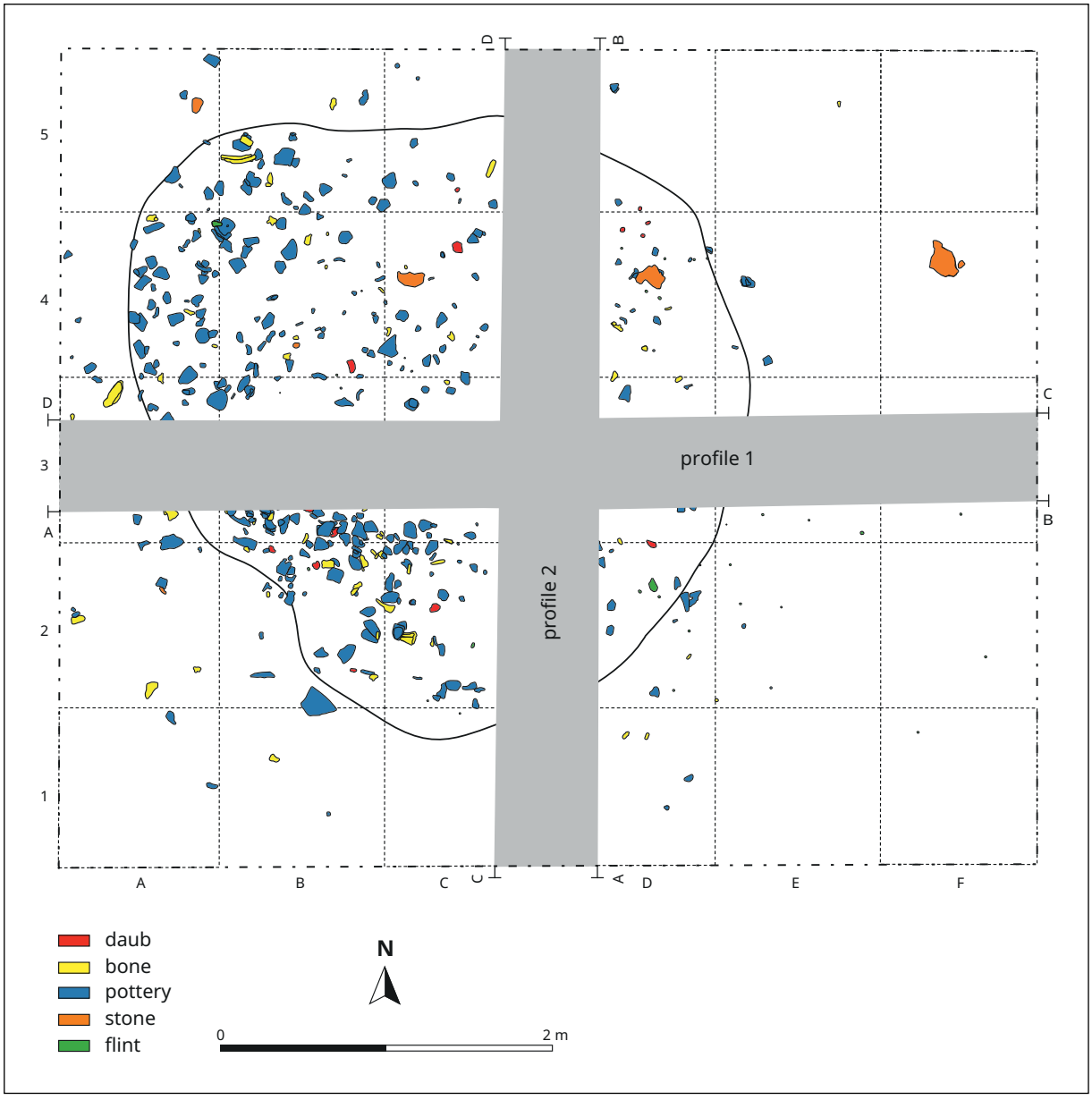


Figure 19. Trench 20, combined excavation plana (graphic: S. Țerna).

Stratigraphy

The following layers were recorded in the cross-profiles (described downwards; Figs. 20, 21):

1. Black arable and unploughed soil with little archaeological material (thickness 40 cm);
2. Dark grey-brown compact silt with an abundant quantity of tiny daub pieces and small shards (thickness 25–66 cm);
3. Lighter grey-brown compact silt with a compact deposition of large pottery fragments, bones, daub and few stones (thickness 3–31 cm);
4. Light grey-brown moderately compact silt with a small amount of finds (thickness 3–17 cm);

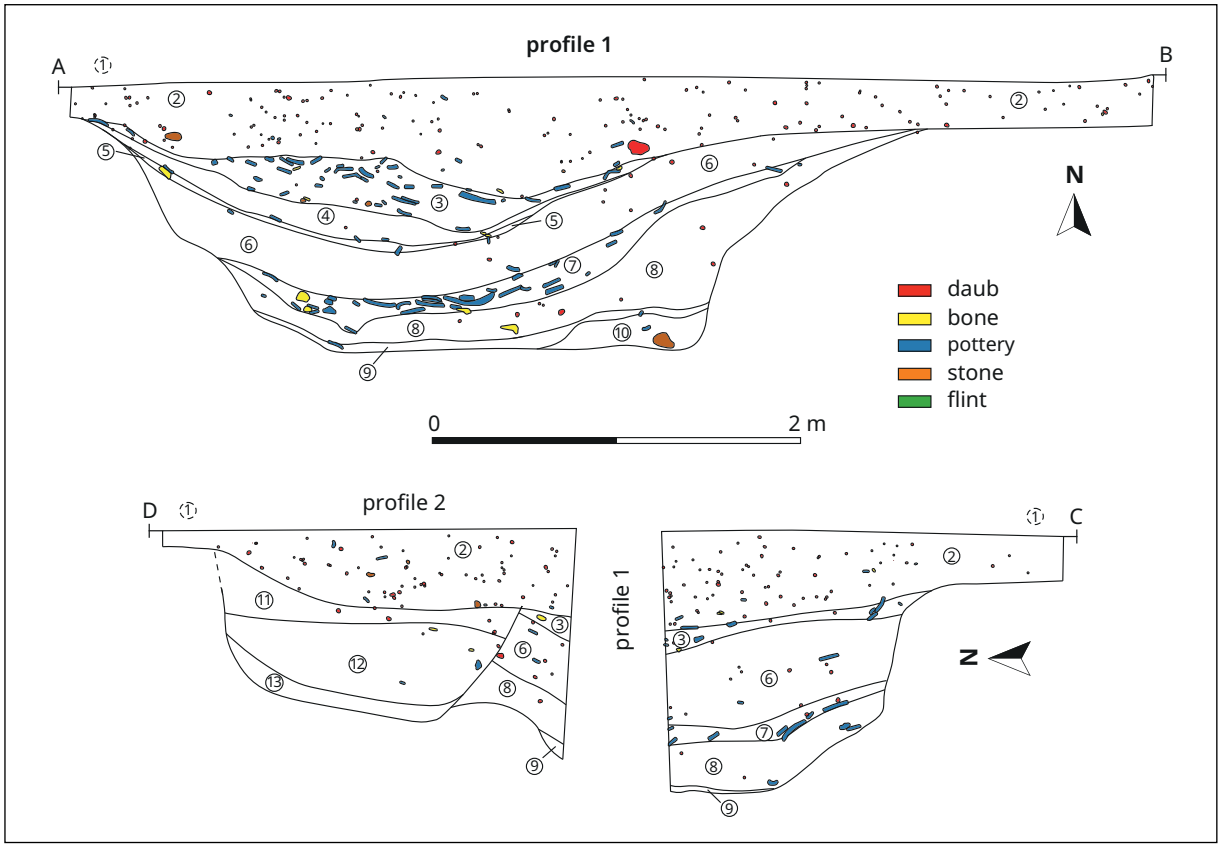


Figure 20. Trench 20, Profiles 1/A–B and 2/D–C. Numbering of layers corresponds to those in the text (graphic: S. Țerna).

5. Mixed yellow-grey-brown silt with a large quantity of ceramic shards (thickness 2–6 cm);
6. Light-grey ashy moderately compact silt with a small quantity of finds (thickness 5–30 cm);
7. Ashy grey-brownish moderately compact sediment with a large amount of large pottery fragments, bones, pieces of charcoal and some small daub fragments (thickness 3–19 cm);
8. Grey-brownish and yellowish moderately compact silt with few finds (thickness 3–56 cm);
9. Yellowish clayish compact sediment with almost no finds and traces of burning (thickness 2–8 cm);
10. Light-brown clayish compact sediment with greenish organic remains and low amount of charcoal (thickness 4–17 cm).

Layers numbered 11–13 refer to a Copper Age pit which is later and cuts across the main dug-out feature (visible in Profile 2/D–C):

11. Grey-brownish moderately compact silt with a small amount of finds (thickness 7–34 cm);
12. Sandy moderately compact silt with a small amount of finds (thickness 11–45 cm);
13. Mixed sandy and grey-brownish moderately compact silt with almost no finds (thickness 3–11 cm).

Interpretation

The dug-out features unearthed in Trench 19 may be reconstructed as having the following succession of chronological events:

1. The pit was dug in order to extract clay for the construction of the adjacent dwelling. The volume of extracted clay may be roughly estimated at 14 m3.
2. After the extraction of the clay, the pit was left open for a certain period. During this time, a package of layers consisting of clayish sediment covered its bottom. These layers were mostly of natural origin: thus, the darker layers represented pluvial sediment while yellowish ones represented the result of the collapse of not yet consolidated and stable enough pit walls. The amount of finds (= discarded waste) was extremely low.
3. The next event is represented by a thick package of layers with a medium amount of finds, ashes and charcoal. This event (the longest from chronological point of view) may be connected to the activity of the nearby building and consists of repetitive discard of household waste and ashes/charcoal resulting from heating of the house.
4. Within this durable sequence, bound to the 'life' of the house, two massive discard events may be discerned. Both of them are characterised by a large amount of large pottery fragments, animal bones, daub, stones, tools and miniatures. The first of these took place sometime at the beginning of the activity of the house, while the second marked its end.
5. After the house was burnt down, the adjacent pit was still visible as a large depression on the prehistoric step-surface. Over time, this depression was partly filled with silt containing high amount of tiny daub fragments and pottery shards, brought in naturally and coming from the debris of the burnt house. By the northern border of pit, however, another one was dug out. This second feature is most probably connected to an activity performed after the γ-house was no more in use, and presumably had already been burnt down.

Trench 21

The trench, oriented in cardinal directions, had an area of 100 m^2 (10×10 m) and was opened over the pit anomaly located by the southwestern short wall of the megastructure. The eastern border of the anomaly was situated at a distance of ca. 6 m from the wall of the building.

Description of features on plana (Fig. 26)

The dug-out feature first appeared on Planum 3 (depth ca. 60 cm) as a large irregular darker area (Feature 21005, area 72 m^2) located in the central and northern parts of the trench, starting approximately from the border between the second and third rows of the excavation quadrats. On the next planum, № 4 (depth ca. 80–90 cm), the contours became more visible and enabled formal delimitation of two features: a large irregular pit in the central and north-western parts of the trench (Feature 21007, area 46 m^2) and a smaller one, approximately oval, adjoining the large pit from the north-central side, partly going under the trench wall (Feature 21008, area 4 m^2).

From this level downwards, the sterile soil outside the dug-out features remained untouched and the excavation focused on the pit limits. At the depth of 100 cm (Fig. 22), it became clear that the two features delimited on the previous planum are in fact a single large pit oriented along the NW-SE axis, with an irregular-oval shape (Feature 21009, area 34 m^2). At this level, two compact find agglomerations have been outlined in Quadrats G/4–5 (Feature 21010) and D–E/4 (Feature 21011). They



Figure 21 (above). Trench 20, photo of the Profile 1/A–B (photo: UFG Kiel).



Figure 22. Pit contour and find agglomerations in Trench 21, Planum 5 (photo: J. Müller).

consisted mainly of pottery shards and animal bones. Moreover, several dispersed smaller find spots (animal bones, large fragments of daub or the base of a vessel) were identified in the north-western sector of the pit.

On the next level (120 cm), the pit had the same shape but reduced in area to 31 m^2. The amount of finds in the planum became larger and built up into an array of three agglomerations oriented north-south along the eastern border of



Figure 23. Find agglomeration 21012, Plana 6–7 (photo: S. Țerna).

the pit. Thus, Features 21012 (Fig. 23) and 21013 (Quadrats D–G/4–7 and D–G/7–8) represented irregular concentrations of pottery, animal bones and single finds on an area of, respectively, 8 and 2 m^2. The ceramic fragments (many of them quite large) came from various kind of vessels, mostly typical conical bowls of different sizes. Several shards from agglomeration 21013 belonged to a large krater. Feature 21014 (Quadrats E–F/8–9) included, among usual finds, the remains of plaster from a clay installation (Fig. 24). These daub fragments had a thickness of ca. 2–3 cm and were made of fine clay with admixture of sand. Some of them preserved traces of red paint.

At the depth of 140 cm (Planum 7), the pit had an area of 29 m^2. The configuration of find agglomerations changed here: the only feature continuing from the previous planum was 21014, while a new small concentration was seen by the western border of the pit, in its central part (Feature 21015, Quadrats B–C/6). Feature 21014 yielded further fireplace remains and, under these, a large agglomeration of massive pottery shards and animal bones was recorded, over an area of 3 m^2. The 21015 agglomeration was smaller and included several vessel fragments and bones.

Both agglomerations continued on Planum 8 (depth 160 cm). Here, Feature 21014 (Fig. 25) consisted of further large pottery fragments (mainly bowls and half-closed vessels), animal bones and small stones scattered over an area of ca. 2 m^2, while Feature 21015 displayed several shards and a grinding stone. The dug-out feature, almost reaching the bottom, displayed a different profile: the main pit reduced to 21 m^2 and two other smaller depressions were contoured under find agglomerations № 21012 and 21014 from previous plana. These two depressions, labelled as Features 21016 and 21017, had areas of 2 and 3 m^2 respectively.

The bottom of the pit (Fig. 28) was encountered at Planum 9 (depth 180 cm). It had an area of 21 m^2. The pit's contour was irregular, generally elongated on the NW-SE axis. In qudarats A–C/6–7, under a thick layer of sterile clay, the dark and



Figure 24. Feature 21014 with discarded fireplace remains, ceramic and bones (photo: S. Țerna).



Figure 25. Waste deposition at bottom of Feature 21014 (photo: S. Țerna).

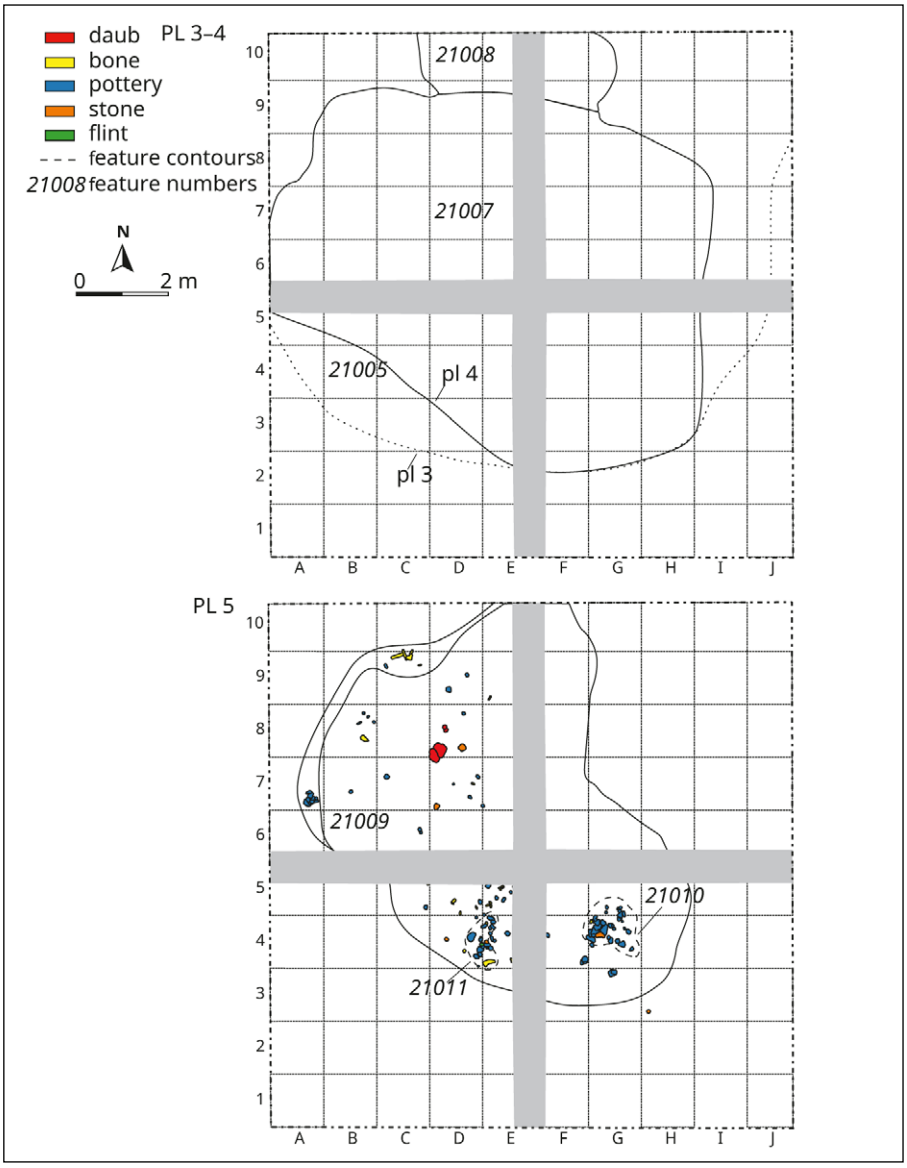


Figure 26A. Trench 21, Excavation Plana 3–5 (graphic: S. Țerna).

extremely compact fill of another pit was identified. The texture of its sediment was totally different from the one in the main dug-out feature. This round pit (21018) continued for another 40 cm, reaching Planum 11 – the last one excavated.

Stratigraphy

The following layers were recorded in the cross-profiles (described downwards; Figs. 29–31):

1. Black arable and unploughed soil with little archaeological material (thickness 40 cm);
2. Dark grey-brown compact silt with an abundant quantity of tiny daub pieces and small shards (thickness 36–71 cm);
3. Grey-brownish moderately compact silt with few finds (thickness 3–19 cm);
4. Grey light-brown moderately compact silt with small pieces of daub, pottery and bones (thickness 2–14 cm);

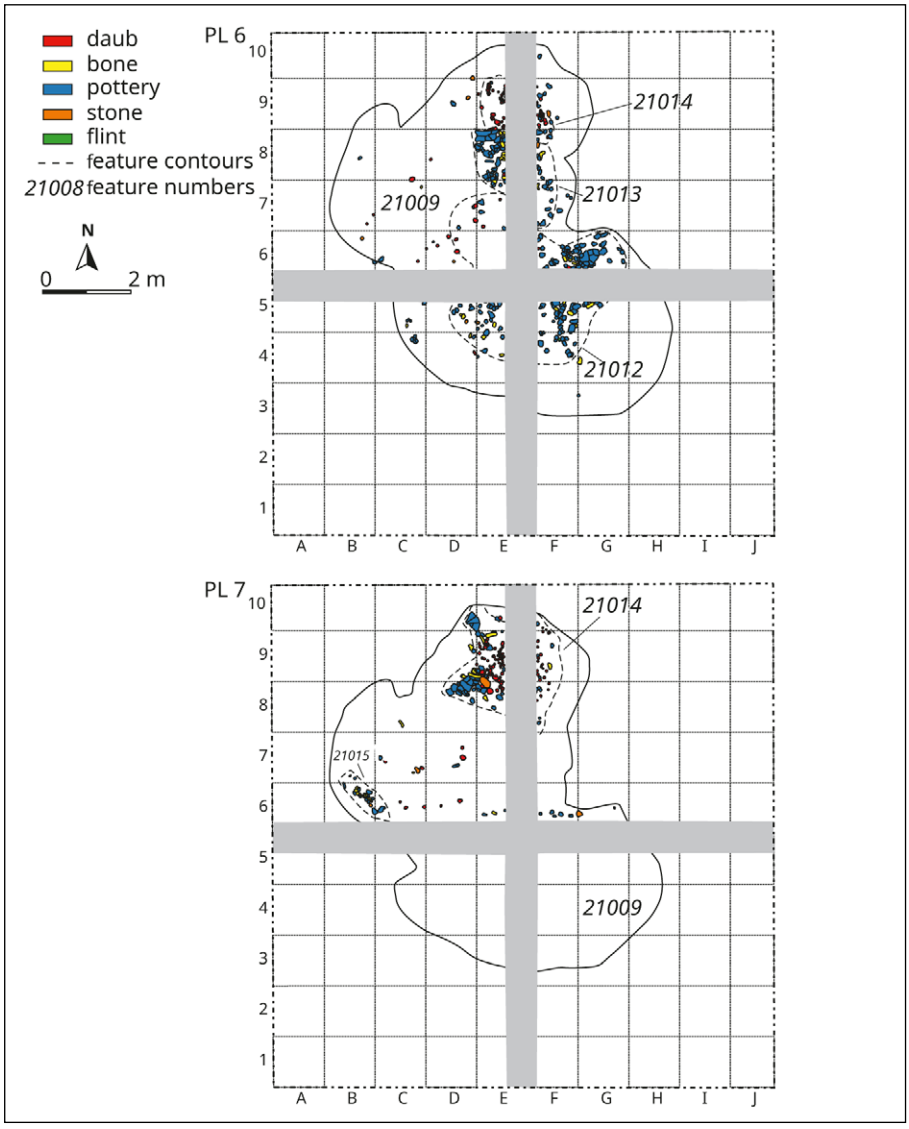


Figure 26B. Trench 21, Excavation Plana 6–7 (graphic: S. Ţerna).

5. Grey-brownish moderately compact silt with a small amount of finds (thickness 4–28 cm);
6. Dark-brown greyish moderately compact layer with a compactly deposited large quantity of pottery, animal bones and other finds (thickness 3–9 cm);
7. Dark-brown greyish moderately compact layer with the compactly deposited remains of a fireplace (thickness 2–10 cm);
8. Dark-brown greyish moderately compact layer with a compactly deposited large quantity of pottery, animal bones and other finds (thickness 3–11 cm);
9. Grey light-brown moderately compact silt with few finds (thickness 3–54 cm);
10. Light-brown moderately compact silt with greenish organic remains and few finds (thickness 8–32 cm);
11. Clayish light-brown/yellowish compact sediment with almost no finds (thickness 3–12 cm).

Layers numbered 12–16 refer to a Copper Age pit which is later and cuts into the main dug-out feature (visible in Profile 2/C–D):

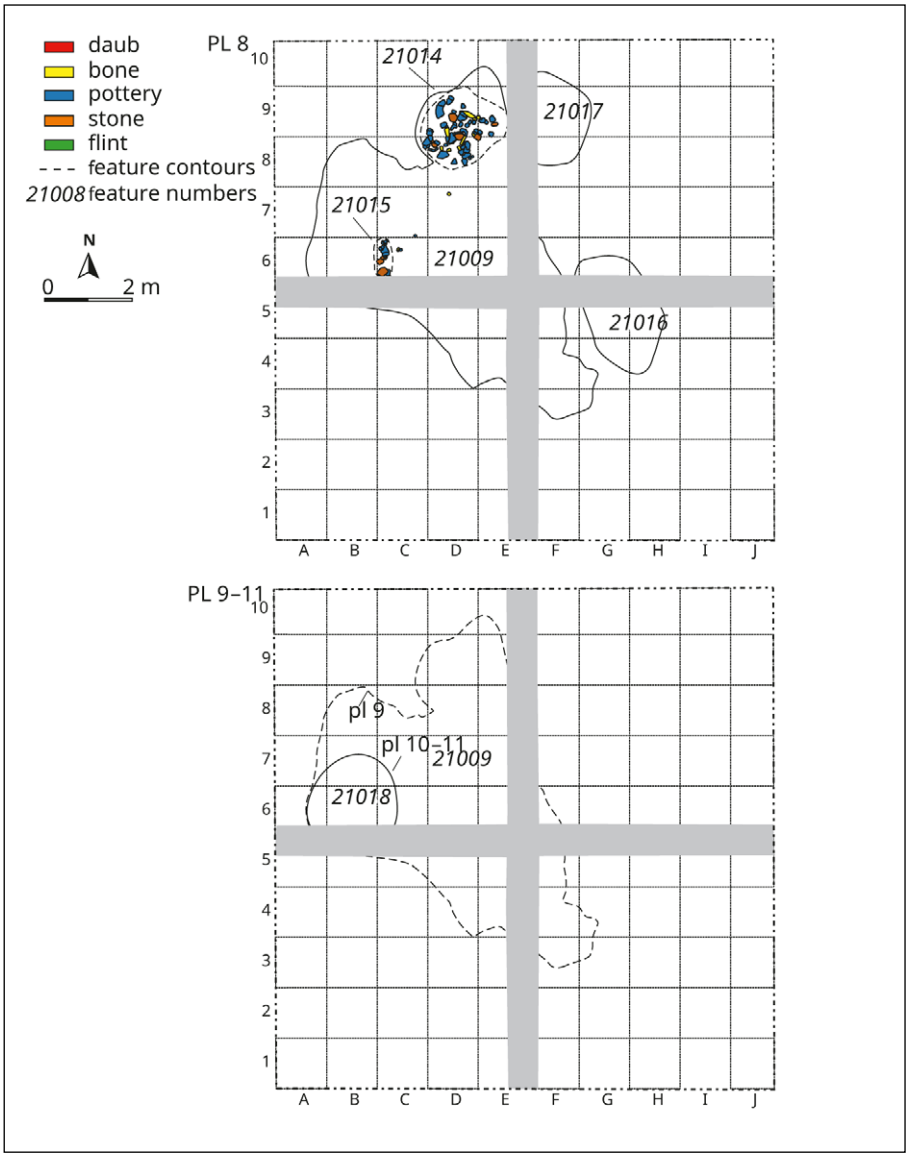


Figure 26C. Trench 21, Excavation Plana 8–11 (graphic: S. Țerna).

12. Light-brown yellowish moderately compact silt with few finds (thickness 32–55 cm);
13. Sterile clay (collapsed pit wall; thickness 38–91 cm);
14. Dark-brown compact sediment with charcoal inclusions and few finds (thickness 15–40 cm);
15. Light-brown moderately compact sediment with few finds (thickness 6–17 cm);
16. Dark-brown compact sediment with charcoal inclusions (thickness 18–32 cm).

Interpretation

For the dug-out features unearthed in Trench 21, we may reconstruct the following succession of chronological events:

1. The main pit was excavated in order to extract clay for the construction of the mega-structure. The volume of extracted clay may be roughly estimated at 52.6 m3. The extraction took place in several stages, as revealed by the several depressions which constitute the pit's bottom. These extractions probably correlated with the

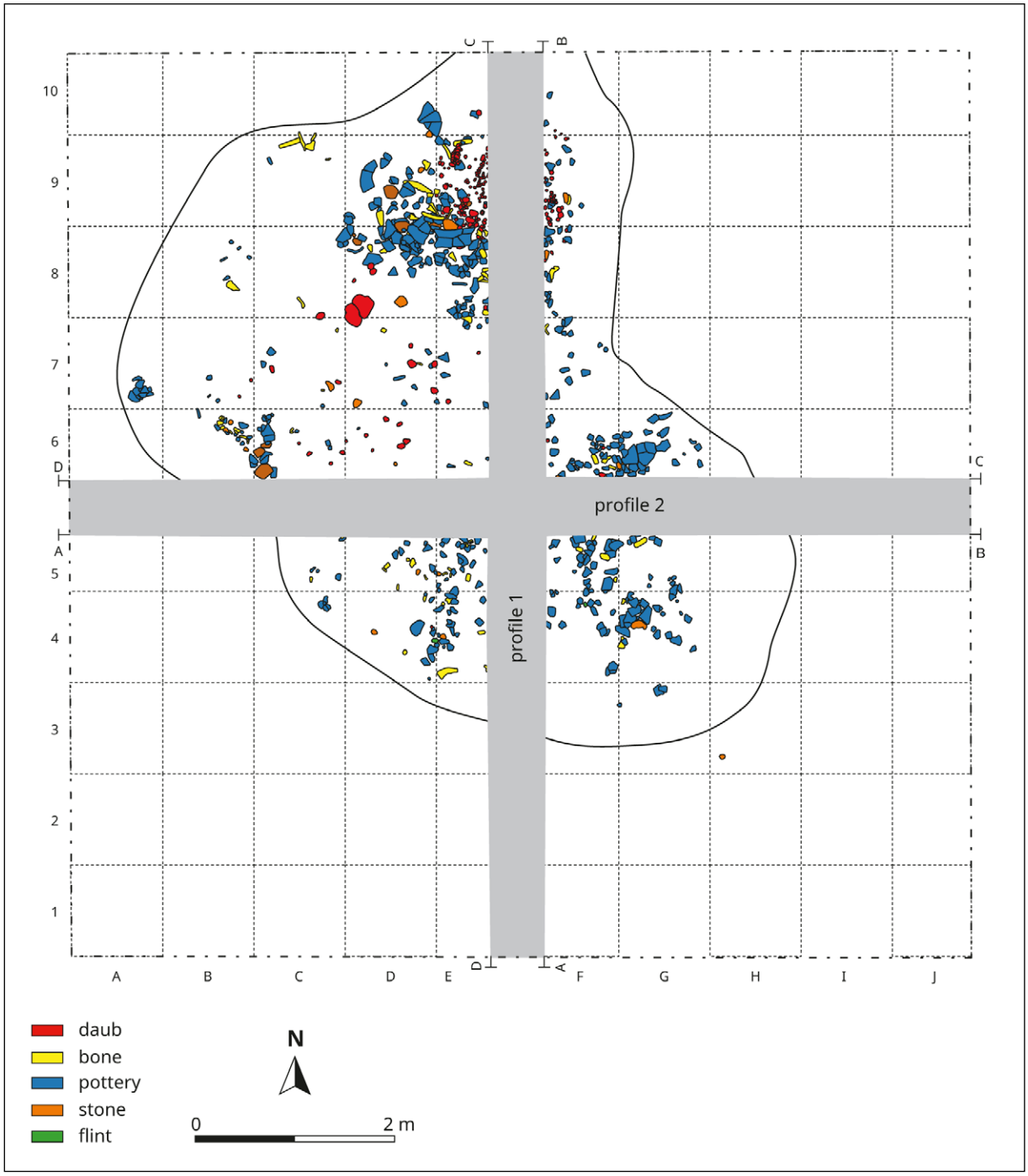


Figure 27. Trench 21, combined excavation plana (graphic: S. Ţerna).

distinct stages of building the mega-structure; we may presume that the largest extraction (Main pit 21007/21007/21008/21009) provided the largest amount of clay for the erection of the walls and clay platform (if any) while the smaller extractions (corresponding to the two smaller depressions 21016 and 21017) could have provided the clay for various installations and furnishings.

2. After the extraction of the clay, the pit was left open for a certain period. During this time, a package of layers consisting of clayish sediment covered its bottom. These layers were mostly of natural origin; darker layers represented pluvial sediment while yellowish ones represented the result of the collapse of not yet consolidated and insufficiently stable pit walls. The amount of finds (= discarded



Figure 28. Trench 21, pit bottom (photo: S. Țerna).

waste) was extremely small. The uppermost layer in this package contained a consistent deposition of greenish sediment which probably came from as yet unidentified organic materials/waste.

3. The next event marks the activity of the mega-structure and is represented by a thick layer which contained most of the pottery, animal bones and single finds. Within this stratum, a funnel-like layer of massive discard from the mega-structure corresponds to the find agglomerations from Plana 5–8 (21010, 21011, 21012, 21013, 21014). Some of the finds are certainly connected to repair and renewal of the mega-structure and its interior.
4. After the mega-structure activity ended, the adjacent pit was still visible as a large depression on the prehistoric step-surface. Over time, this depression was partly filled with silt containing high amounts of tiny daub fragments and pottery shards, brought in naturally and coming from the debris of the burnt building. A cylindrical pit was dug out by the western border of the pit. This second feature is most probably connected to an activity performed when the mega-structure was no more in use, and presumably already burnt down.



Figure 29. Trench 20, Profile 1/C–D (photo: S. Țerna).

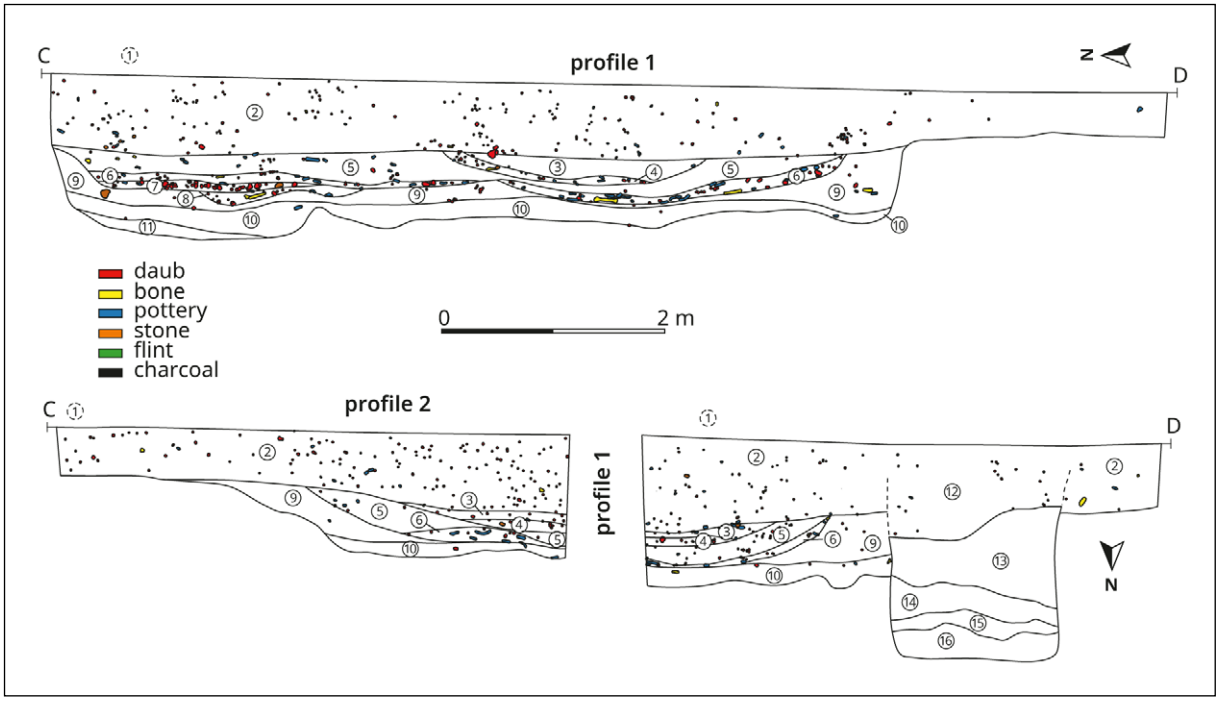


Figure 30. Trench 21, Profiles 1/C–D and 2/C–D. Numbering of layers corresponds to those used in the text (graphic: S. Țerna).



Figure 31. Trench 21, Profile 2/C–D on Excavation Quadrats E–A, with the later pit cutting into the main one (photo: S. Țerna).

Comparative analysis of the four pits

Stratigraphy

In principle, all of the four systematically investigated pits display similar biographies, with four major refill events (Fig. 32). We assume that all these pits were dug in order to extract clay for house construction. It is therefore no surprise that the volume of extracted soil shows quite a tight positive correlation with the area of the associated nearby building (Fig. 35). A package of thin clayish layers covered the bottom of the open pit during clay extraction and building construction. These represent the sediment coming from the still unstable and partly collapsed walls of the dug-out feature, mixed with human discard and soil washed in by rain.

The period of the activity of the nearby building is marked by a solid layer of silt with charcoal and ashy components which contained many finds. This layer has a funnel-like configuration, as during the long-lasting repetitive discard of waste from the dwelling, the debris first became agglomerated under the pit's walls and later moved towards its empty central area. The ashes and charcoal are most likely to have come from heating installation(s). In this context, it is striking that the 'activity layer' from the pit by the mega-structure does not display any massive ashy components which could be observed with the naked eye. It seems probable that the Stolniceni mega-structure was not equipped with an oven, in contrast to residential dwellings, and so did not produce a large amount of ashes. Similar situations were recorded at the mega-structures excavated at Ukrainian mega-sites; none of them contained oven remains (Hofmann *et al.* 2019, 35).

Within this 'activity layer', one or two massive layers with a high density of finds are observable. They reflect short and intense discard events. In our opinion, these events should be connected to surface clearance of the area around the house.

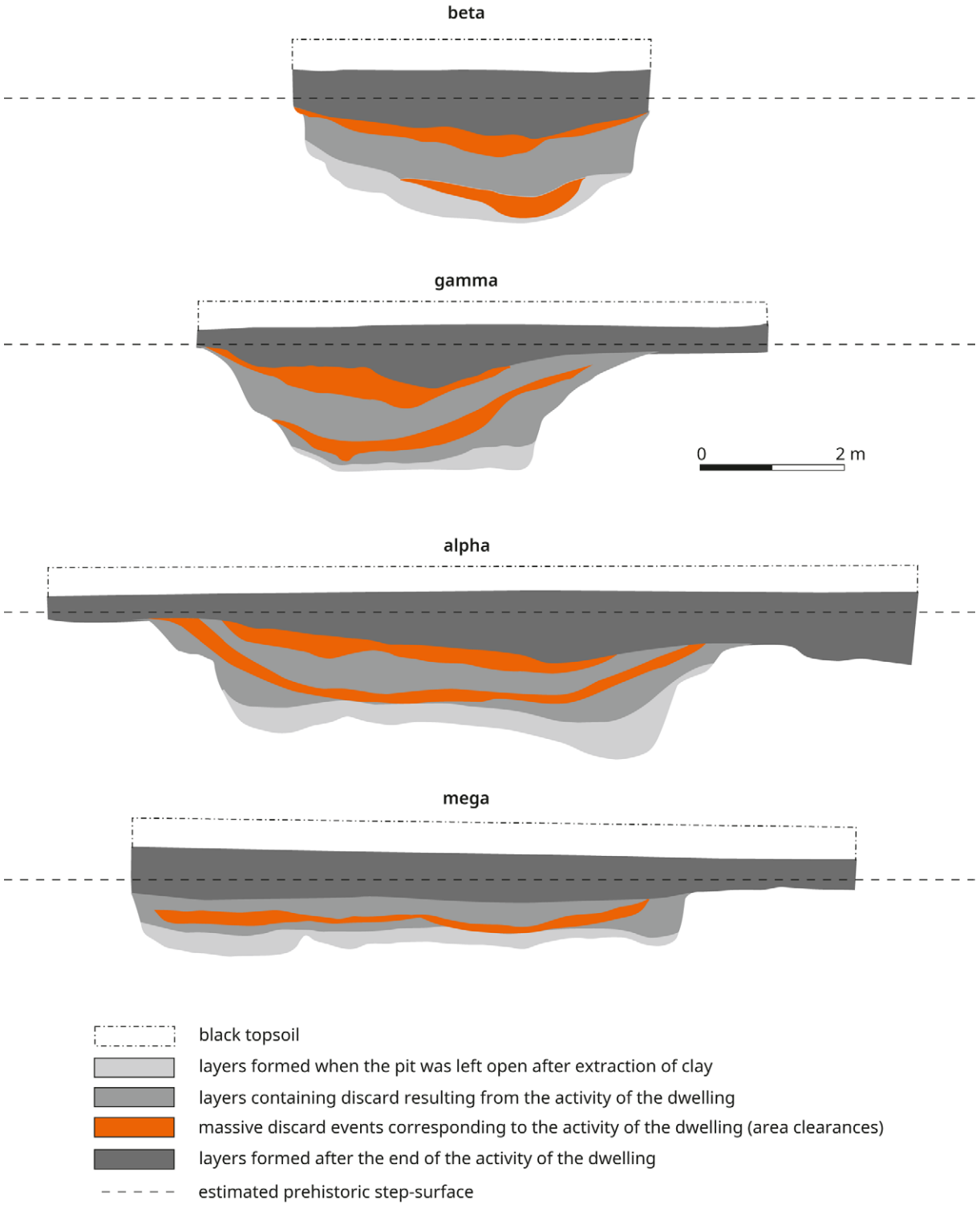


Figure 32. Simplified representation of the main refill events in the four excavated pits (graphic: S. Țerna).

Generally, the step-surface among houses on mega-sites is fairly 'clean' and does not host many archaeological remains; on the other hand, this area would obviously have been an area for intense routine activities. This apparent contradiction can be easily explained if we presume that the area was deliberately cleaned and the waste was discarded into the pits. Exceptions from such a scenario actually support this: a substantial amount of pottery, daub, tools, miniatures and animal bones have been recorded around the dwelling excavated at Stolniceni in 2017 (Țerna *et al.* 2019, Fig. 24), while the pit related to this house did not display such massive short-time discard events in its stratigraphy. A similar situation was seen at Bilyi Kamin in Ukraine (Rud *et al.* 2019, 55), where the areas beside two excavated houses contained waste layers. In contrast, at Stolniceni, a long test trench (№ 13) placed over the lateral extremities of the α- and β-houses covered entirely the space between them and did not display much waste on the step-surface; the same observation has been made in other test trenches (№ 11 and 12 – cf. Țerna *et al.* 2019, 252–256). The 2018 and 2019 excavations of the large pits connected to the α- and β-dwellings revealed massive discard events in the pit refill and this may be an explanation for the relatively 'clean' inter-dwelling area.

It is striking that all of the three pits from the house-group contained two such 'surface clearance layers'. The upper one is always located directly on top of the 'activity layer'. We may therefore presume that it contains waste collected and discarded close to the end of the activity of the respective dwelling. It is most probable that this practice can be related to preparation for intentional burning. Since the burning of the house was surely an event of tremendous social and ideological significance, it is no surprise that the 'set' or 'scene' for it was arranged beforehand, implying a thorough cleaning of the area. As regards the lower 'surface clearance event', its relative chronological context is not so clear. In stratigraphical terms, it should have occurred at some point in the early phase of building's existence, since the 'activity layer' below this event is thinner than the one overlying it. It may not be directly connected to an eventual surface cleaning before the construction of the house, since it is not located exactly at the bottom of the pit or in the lowermost sequence of the 'activity layer'. It is probable that, at a certain time in the evolution of the houses, the area was thoroughly cleaned; one could even assume that this was done on certain special occasions of social/integrative significance. Whatever the case, further processing and assessment of the finds from the two layers of quick massive discard will probably help us to better understand and interpret them.

After the house activity ended (and the area around was cleaned before intentional burning), the pits were definitely still well-visible in the Stolniceni intra-site landscape, as large depressions reaching a depth of several dozens of centimetres below the prehistoric step-surface. At some time, other pits were dug from this layer, within or outside the older ones, as witnessed in Trenches 19, 20 and 21. These pits may be linked to settlement activities from the times after the end of the respective dwellings' use and which therefore support the idea of the long duration of a mega-site.

Preliminary observations on find stratigraphy

Since the processing of the finds from the four pits is still in progress, we will limit ourselves here to an interim presentation of the quantity and contextual distribution of tools and clay miniatures recorded as single finds in the field. The assessment of bulk finds (mainly pottery, daub and animal bones) will be presented in the future.

Trench	All	Flint	Polished stones	Bone and antler tools	Figurines	Tokens	Clay balls	Copper
16	722	542	18	36	54	10	3	6
19	686	534	9	18	66	9	3	0
20	408	273	21	16	43	8	5	0
21	1276	914	10	47	99	16	3	3
Total	**3092**	**2263**	**58**	**117**	**262**	**43**	**14**	**9**

Table 1. Quantity of small finds in the excavated pits.

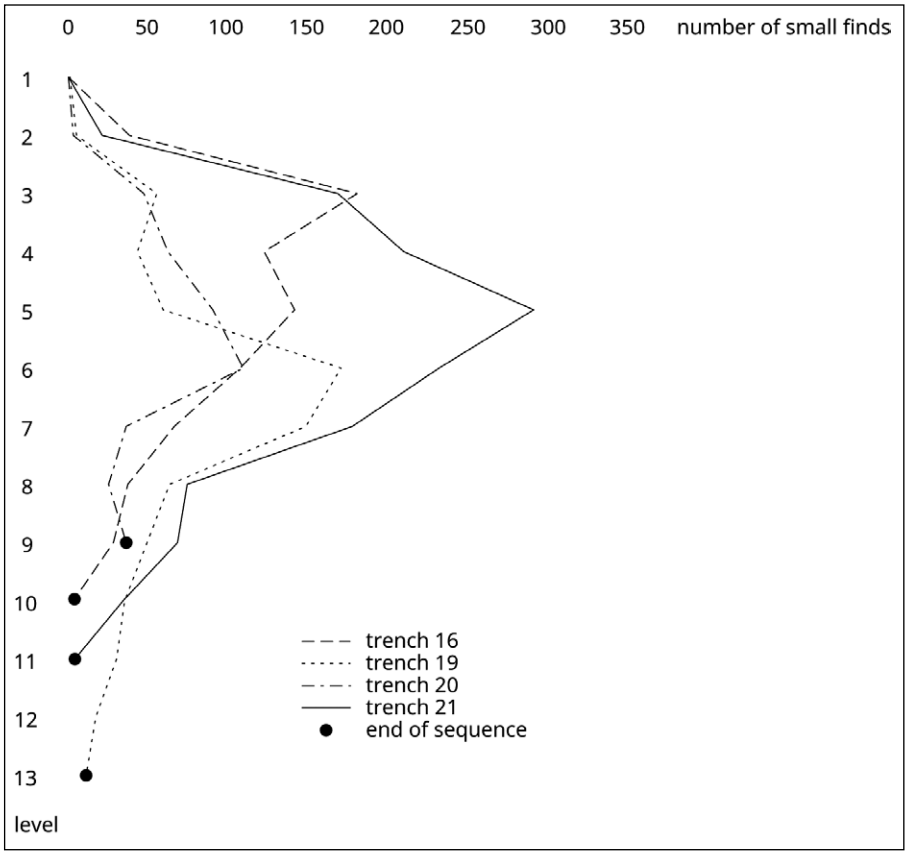


Figure 33. Distribution of small finds on excavation plana (graphic: S. Ţerna).

Our excavations yielded an impressive amount of over 3000 small finds which belong to various categories, such as flints, polished stone, bone and antler tools, figurines, tokens, clay balls and copper implements (data in Tab. 1).[2]

Within the fill of the pits, these finds are distributed unevenly. Thus, by simply plotting the quantity of small finds by their depth level (Fig. 33), we may observe that variations in small find quantities correspond to the main refill events summarised above. The 'activity layers' with discard from adjacent dwellings are clearly noticeable on the plot; moreover, for Trenches 16, 19 and 20, there are two peaks of varying intensity which are connected to the two 'surface clearance' layers.

2 The total amount of small finds may be slightly higher than is presented here since certain artefacts were very probably collected together with the bulk finds. The final assessment of the quantity of small finds will be presented after the processing of all the finds. Nevertheless, the data indicated here certainly do cover the large majority of finds and are therefore relevant for drawing some conclusions.

In principle, the quantitative distribution of small finds supports our interpretation of the general pit stratigraphy and should be complemented by detailed qualitative assessment of the assemblage.

Consequences for the study of the settlement's socio-economic structure

Based on the available data, we can now make a preliminary estimation of find spectrum and density for each pit and try to link this to the characteristics of the respective dwellings. Here, we will consider only the finds and size of the main dug-out feature, excluding the later overlying ones.

These calculations are presented in Table 2.

The results may be presented as a stacked histogram and plotted on a scatter plot which displays the relationship between pit volumes and house sizes (Figs. 34, 35).

Two main tendencies can be deduced from the data presented above. First, the density of finds is inversely proportional to the dimensions of the dwelling. Second, there are two 'poles' in terms of dwelling area, pit volume and find density: one of these includes the β- and γ-houses while the other comprises the α-house and the mega-structure. To what extent may these differences offer insight into the

Trench	Dwelling	Flint	Polished stone	Bone and antler	Figurines	Tokens	Clay balls
16	β	21.5	0.76	1.5	2.3	0.3	0.08
20	γ	19.4	1.5	1.1	3.0	0.6	0.36
19	α	9.7	0.15	0.35	1.4	0.17	0.06
21	Mega	16.5	0.2	0.9	1.8	0.3	0.06

Table 2. Density of small find types for each of the excavated pits (finds/m³).

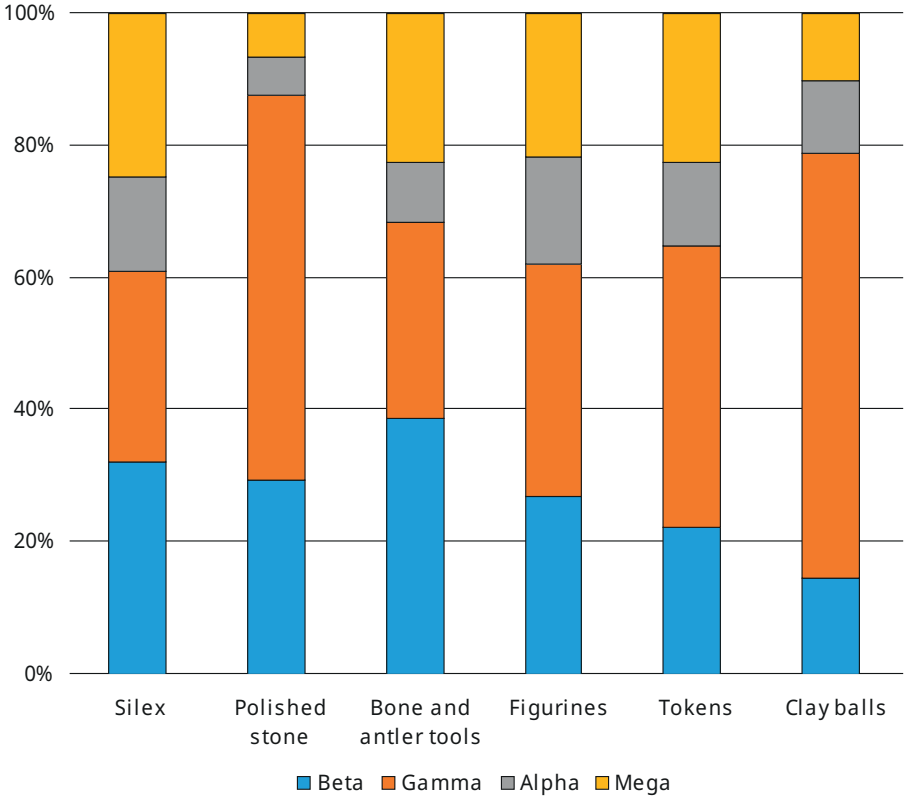


Figure 34. Stacked histogram showing density ratio of each find category across the four pits (graphic: S. Țerna).

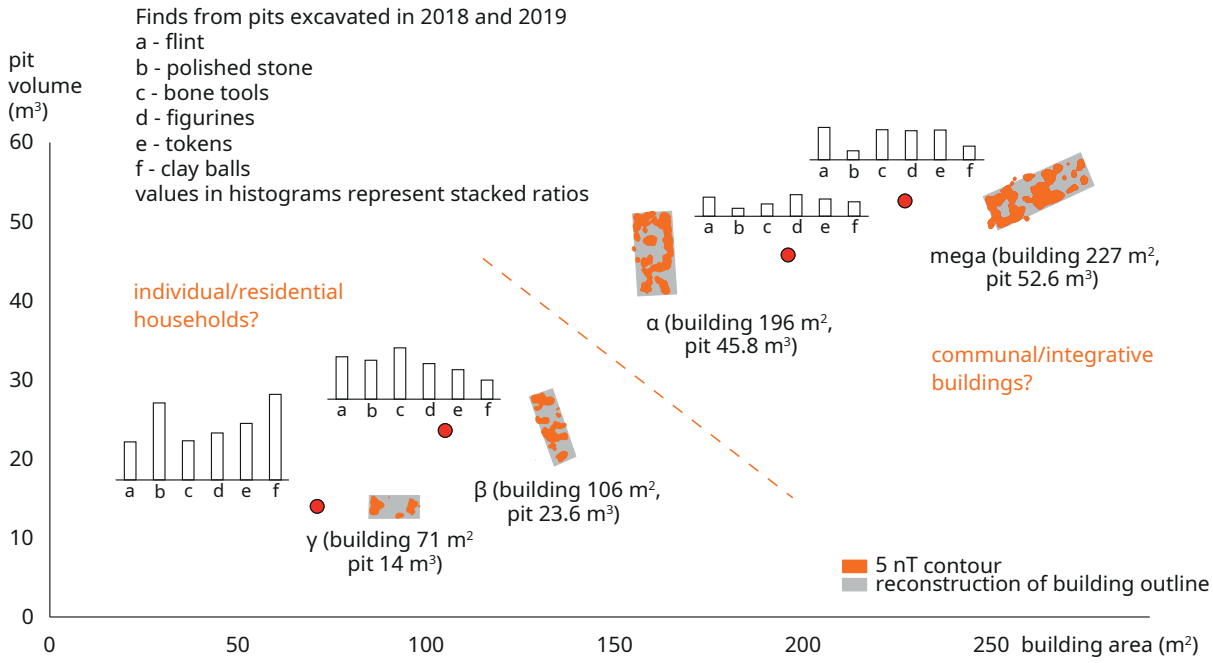


Figure 35. Correlation between sizes of dwellings, pit volumes and find densities (for the latter, data are from Fig. 34; graphic: S. Ţerna).

socio-economic structure of the site? The size of the α-dwelling is much closer to the one of the mega-structure than to the β-and γ-houses. Furthermore, from the 2017 test trench we know that, in contrast to the β-house, the α-dwelling had a distinct single-storey architecture, not the regular two-storey kind with platform. This interpretation is supported by the geophysical signature of the α-house, which displays anomalies from walls and an empty interior, with a probable installation in the centre of a larger room. As for the mega-structure, the geomagnetic anomaly suggests a bipartite configuration, with the interior only partly containing daub deposits and most likely to be lacking a clay platform (cf. Hofmann *et al.* 2019, Fig. 22). Since the architecture of the mega-structures is widely considered as a crucial criterion which, alongside large dimensions and central positioning, contrasts them to regular residential dwellings, the same idea can be extrapolated for the α-house.

Thus, there are so far three indications that the α-house is closer to being a communal integrative facility such as the mega-structure, rather than to residential dwellings; these are its size, architectural particularities and the density of finds in the adjacent pit. To this one can add its position, since, as mentioned in the beginning of this paper, almost every trapezoidal house-group from the external circuit includes an oversized radially-oriented α-dwelling.

In other words, an α-dwelling could play an integrative, central role for each house-group. If such an interpretation is correct, could the β-houses located nearby be inhabited by wealthier families (as indicated by the six copper objects from the respective pit)? Did the γ-houses therefore house the most numerous 'regular' families, which would build the basis of a kind of hierarchical pyramid? These are questions which cannot be answered now but will be addressed again after a comprehensive assessment of all the finds, estimation of pit duration and chronology as well as faunal and botanical determinations. The real picture might be much more complex and not so linear; nevertheless, even these preliminary results presented above do illustrate the potential of pit excavation as a complex source of various proxies for socio-economic studies.

Find description

Pottery

The pottery assemblage (Figs. 36–43) recovered from the four pits is still being processed. Nevertheless, we can state with certainty that it is a huge assemblage, exceeding several tens of thousands of fragments.

From a technological point of view, the ceramics display the three main categories attested at Stolniceni in previous years (and generally typical for late Trypillia stages). The absolute majority of shards belong to the fine category, made out of paste with no visible impurities, homogenously and well fired. The second category includes shards made of white kaolinite fine clay. The third comprises coarse pottery made of paste with admixture of crushed shell and shards, unhomogenously fired. Some of the vessel bottoms display imprints from the piece of clothing placed underneath during modelling.

The spectrum of morphological shapes includes bowls, goblets, goblet-like vessels, amphorae, kraters, sphero-conical and pear-shaped vessels, lids and four-legged containers (fine ware) as well as bowls, four-legged and krater-like vessels (coarse ware).

Various techniques have been used to ornament the ceramics. For fine ware, the most common one is painting applied over an engobe background. The decoration on coarse ware displays a combination of incisions, impressions and grooves.

The painted ornamentation is mono- (black colour), bi- (black + red or black + white colours) or trichrome (black, red and white colours). Within the structure of the ornamentation, the black decoration predominates, while red and/or white motifs repeat the layout of the main one. Most often, red ornamentation fills the space, framed by black lines, while white ornamentation frames the black ones. White ornamentation occurs very rarely at Stolniceni; in the four excavated pits, it has been recorded so far exclusively in Trench 21 which was located over the pit connected to the mega-structure.

Painted patterns are organised in a hierarchical way. Thus, distinct stylistic elements are used to create ornamental schemes, some of which are mainly characteristic for a certain morphological vessel type. Conical bowls bear comet-like and figure 8-like schemes, metopic ornamentation is used on goblets and goblet-like vessels, while half-closed large vessels such as kraters, pear-shaped vessels or amphorae display wavy, 'horizontal 8' and *Tangentenkreisband* patterns.

Although organized in similar schemes, the stylistic elements display high variability. The most general and frequent are half-ovals and curvilinear lines. We noted in particular many 'reversed S' elements on bowls, cruciform elements on goblets, and zoomorphic, ornithomorphic and anthropomorphic elements on half-closed vessels.

Two special categories of fine ware are the four-legged zoomorphic vessels and the miniature pottery. Zoomorphic containers were found in all of the four trenches; most often, the four legs sustain a bowl-like container which is sometimes painted. In some cases, a plastic application under the rim depicts the animal's snout. A distinct morphology was recorded for a fragmented zoomorphic container from Trench 20: it has a shallow body, traces of bi-chrome painting and a realistically modelled tail; unfortunately, the frontal and lower parts of the item are not preserved. Miniature vessels (most of them found in Trench 20) usually have a rounded belly, short neck and straight or deflected rim. Some of them bear traces of engobe and mono- or bi-chrome painted decoration.



Figure 36. Agglomeration of pottery fragments including part of a 4-legged vessel in Trench 19 (photo: UFG Kiel).



Figure 37. Vessel with complete profile from Trench 19 (photo: UFG Kiel).



Figure 38. Fragments of a large storage vessel with barbotine decoration from Trench 20 (photo: UFG Kiel).



Figure 39. Pottery fragments from Trenches 19 and 20 (photos: A. Heitmann). Scale 1:2.

As regards the coarse ware, most of it bears impressions of various shapes (rectangular, oval, round, pseudo-cord, 'comb') combined with plastic knobs, grooves and horizontal, angular, curvilinear and wavy incised lines.

Miniature objects of fired clay

The spectrum of clay miniatures recovered from the four pits consists of both anthropomorphic and zoomorphic figurines, conical tokens, 'clay rods' and pendants.

Anthropomorphic figurines (Fig. 44)

The anthropomorphic figurines comprise the most numerous category. They are made of well-fired clay with almost no visible impurities, similar to the paste used for fine pottery ware. The shaping of the body was made of two pieces of clay. On certain figurines remains of the thin clay slip (engobe) are visible; usually, these items display traces of painting. It is probable that most of the figurines were painted and their actual appearance is strongly influenced by taphonomic processes which affected the surface of the objects, often destroying both the painting and the engobe underneath.



Figure 40. Pottery fragments from Trench 20 (photos: A. Heitmann). Scale 1:2.

From a morphological point of view, most of the figurines are standing, with short conical arms, a single (sometimes fusiform) leg and schematic discoid head. One single item belongs to the 'realistic' category – a figurine from Trench 19, with eyes, nose, mouth, ears and dotted headdress shown on the head. This is only the second figurine of this kind found at Stolniceni, following the one found in 2017 (Țerna *et al.* 2019, Fig. 58). The breasts are usually depicted as small clay knobs while dots and incised lines indicate the umbilicus and female sexual features. Often, the arms and the hips are perforated.

As mentioned above, some of the items bear traces of painted decoration. In several cases, this completely covers the surface of the figurine (red colour) while in others black linear ornamentation has been painted over the reddish background. On several figurines deep incisions depict a neck adornment (necklace).

Taken as a whole, the large quantity of anthropomorphic figurines from 2018–2019 excavations at Stolniceni (over 180 items) substantially enlarges the assemblage recovered in previous years, bringing it to an impressive amount of ca. 245 finds.



Figure 41. Pottery fragments from Trenches 19 and 21 (photos: A. Heitmann). Scale 1:2 (1–7) or 1:3 (8).



Figure 42 (above). Fragments of 4-legged and miniature vessels (photos: A. Heitmann). Scale 1:2.



Figure 43. Pottery shards including a fragment of a 4-legged zoomorphic vessel discarded in the pit in Trench 21 (photo: S. Țerna).

Zoomorphic figurines (Fig. 45)

Nearly 90 zoomorphic miniatures were discovered in the four pits. They are modelled from two types of clay – one with admixture of burnt chalk or flint(?) and the other with minimal visible impurities, similar to the clay of fine pottery ware. The latter category is by far the most numerous. The firing is usually good and homogenous. Some of the items have been exposed to secondary burning. On the surface of a small number of the figurines, human fingerprints are clearly visible, left during hand-shaping of the item.

Morphologically, the great majority of the specimens depict bovines and small domestic ruminants (sheep/goat). Limbs, tail, udder, phallus, snout and horns are usually rendered in a plastic manner. Several figurines have a distinct morphology and may be interpreted as representations of wild animals (deer, boar and hedgehog).

Most of the items lack any ornamentation; however, on several of them, traces of paint can be observed. The body of one figurine is covered with dotted decoration.



Figure 44. Anthropomorphic figurines (photos: A. Heitmann). Scale 1:2.

Conical tokens (Fig. 46)

The excavations yielded almost 60 conical tokens. These are usually small, with the diameter not exceeding 2 cm. They are made of fine well-fired clay with a minimum of visible admixture. Rarely, incised lines decorate the upper surface of the items. Interesting to note is one token with zoomorphic traits found in the pit by the mega-structure; it resembles the specimens from the renowned set (49 items) combining 'regular' and zoomorphic tokens, found in a burnt dwelling at the early Trypillia C1 settlement of Konovka (Ryzhov and Shumova 2013; Balabina 1997; Balabina 1998, 165–166).

'Clay pegs' (Fig. 46)

This less numerous type of miniatures comprises the specific *clay pegs* (*Tonstifte)* or elongated cylindrical items with multiple complete or partial perforations and conical or slightly bent extremities, the latter resembling an animal snout (Uhl 2018). It has been suggested that, alongside conical tokens, these items could have been used for some kind of counting system (Uhl 2018, 8–11).



Figure 45. Zoomorphic figurines (photos: A. Heitmann). Scale 1:1.

Pendants from Trench 21

A very interesting find was the three pendants made of clay and stone recovered from the pit by the mega-structure[3]. The clay items are ornamented with incised patterns and, in one case, dotted impressions, whereas the stone pendant is not decorated. All of them display perforations for suspension. So far, these finds do not have direct analogies with other contemporary Cucuteni-Trypillia settlements, although one of the clay pendants reminds of the lobed items depicted on certain anthropomorphic figurines.

Copper (Fig. 47)

For the first time at Stolniceni, the systematic excavation of these four pits yielded copper objects. Six of these were found in the pit at Trench 18 and another three in

3 The pendants will be published in a separate article.

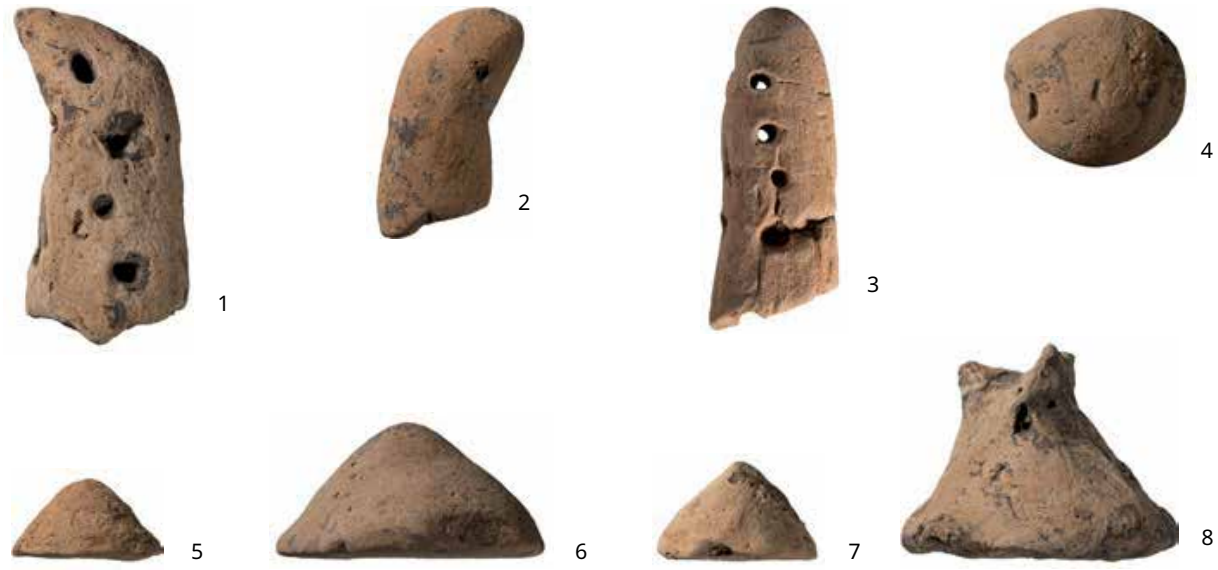


Figure 46. Clay ball, 'pegs' and tokens (photos: A. Heitmann). Scale 1:1.



Figure 47. Copper finds from Trench 21 (photos: A. Heitmann). Scale 1:1.

the pit at Trench 21. Despite a relatively small assemblage, the spectrum of copper items is quite variable and includes both circular and tubular beads, awls, a piece of wire, a fragment of sheet and an ingot.

Bone, antler and tooth artefacts (Fig. 48)

The spectrum of bone, antler and tooth artefacts displays the same morpho-functional types as those identified in the assemblages from previous campaigns. Bone served as the main raw material for the manufacturing of awls and projectile points; as well as these, beveled tools and tubular beads should be mentioned. The antler assemblage is poorly represented and mainly includes fragments of perforated objects, while large ruminant teeth were used as adornments.



Figure 48. Artefacts of animal hard tissues (photos: A. Heitmann). Scale 1:1 (1–10) or 1:2 (11–12).

Generally, as is the case of other find categories, the amount of bone, antler and tooth artefacts recovered from the four pits exceeds by far those found in other types of features in previous campaigns.

Chipped stone (Fig. 49)

Chipped stones category is represented mostly by silicious rocks (chert), crystalline rocks (granite) and few other kinds of rocks, which are not representative. Chert, commonly known as flint, emerges as the primary material shaping the economic activities within the settlement. The chert objects from the 2019 excavation

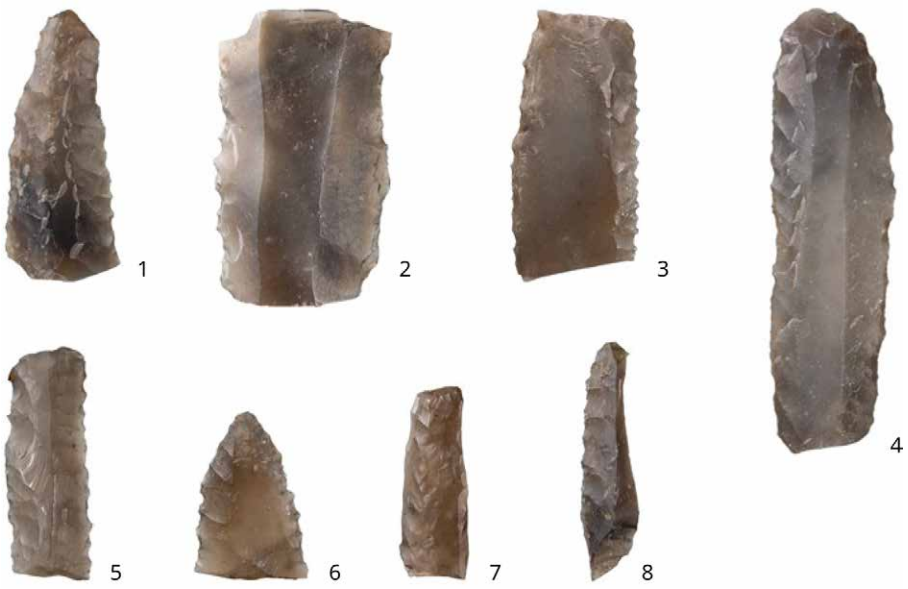


Figure 49. Chipped stones (photos: A. Heitmann). Scale 1:1.

encapsulate the entire spectrum of tool production, ranging from implements tailored for bone processing and leather production to tools essential for hunting and agricultural activities. Significantly, the volume of chert artefacts discovered in the pits markedly exceeds the count from previous excavations.

A diverse array of waste materials, including cores, flakes, and debris, is observable within chert artefacts. The composition of raw materials exhibits variability across artefacts, predominantly featuring locally sourced cherts intermingled with presumably imported varieties. This pattern suggests a compensatory strategy in response to the scarcity of local raw materials, prompting a consistent inflow of materials from external sources, both at micro- and macro-regional scales.

The lithic industry pivots towards blade production, with blades serving as the primary templates for subsequent tool manufacturing. Nevertheless, a substantial portion of the archaeological assemblage consists of artefacts crafted on flakes, contributing to a nuanced understanding of the settlement's technological practices.

Trench 22

In 2019, we opened an initial trench outside the Copper Age settlement in order to investigate the elongated linear anomaly which leads from the southern border of the Copper Age settlement towards the river. It had been presumed that this anomaly, well-distinguishable both on the geophysical plan and the drone imagery (see Scholz *et al.* 2018), represents a Copper Age trackway which connects the site with the Ciuhur riverbed. Since this anomaly goes under one of the Late Bronze Age 'ashmounds' from the Stolniceni II settlement (Sîrbu and Țerna 2017), we wanted to check if the Bronze Age features could better preserve the surface and contents of the possible Copper Age track, protecting it from intense bioturbation, which is so characteristic for Eastern-European black soils.

Configuration

The trench, oriented east-west, had an area of 26 m^2 (13×2 m) and was opened over the location where a Late Bronze Age 'ashmound' overlaid the linear track-like anomaly (Fig. 50).



Figure 50. Location of Trench 22 over the Late Bronze Age 'ashmound' and the extremity of the linear structure (photo: J. Müller)

Description of features on plana

Across the entire trench, the first 50 cm excavated consisted of homogenous light-greyish unconsolidated soil with fragments of pottery, bones and unworked stones. Starting with Planum 3, variations in soil texture and colour allowed us to discern distinct features. Thus, on Planum 3 (depth ca. 70 cm), two features were identified (Figs. 51, 55). In the western part of the trench, a stripe of darker greyish and light-brown soil marked Feature 22003 (Quadrats A–D/1–2). It contained several fragments of vitrified daub and, generally speaking, a small amount of finds except for a concentration of large unworked stones but these could not be linked to the remains of any kind of construction. On the rest of the planum (Feature 22004), the soil was similar to that in the upper 50 cm: greyish, ashy, with moderate presence of pottery, bones and stones (mainly unworked). Several dispersed fragments of daub were also found, one of them vitrified.

At the depth of ca. 90–100 cm (Planum 4), the trench displayed the same division into two main areas (Figs. 52, 55). The smaller one, located in the western part of the trench, contained two features: a stripe of dark-brown clayish soil in Quadrats A/1–2 (Feature 22008) and a layer of trampled earth appearing as easily detachable brownish compact lumps in Quadrats B–E/1–2 (Feature 22005). The larger area (Feature 22007, Quadrats E–M/1–2) represented the continuation of the light-greyish unconsolidated soil from the above levels. It contained a moderate quantity of pottery and bones as well as some charcoal pigmentation. From this layer came a Trypillia shard, which was found in Quadrat K/1.

This configuration of features continued on Planum 5 (depth ca. 120 cm), with the brown clayish Feature 22008 in the westernmost quadrats and the brownish substrate of the trampled earth from Planum 4 (Feature 22005). Within the greyish unconsolidated soil of the main part of the trench (Feature 22007), an oval light-grey



Figure 51. Trench 22, Planum 3 (photo: J. Müller).



Figure 52. Trench 22, Planum 4 (photo: J. Müller).



Figure 53. Contour of Pit 22009 (photo: A. Vornicu-Țerna).



Figure 54. Profile of Pit 22009 (photo: A. Vornicu-Țerna).

feature was visible in Quadrat G/2 (Feature 22009; Figs. 53–55). This was a shallow (depth 10–12 cm) pit (posthole?) with a large amount of charcoal.

Since at Planum 5 the trench was already some distance below the usual Copper Age step-surface level (ca. 60 cm), several cores were drilled in order to check the lower stratigraphy. Thus, in the central part of the trench, one core revealed a further 80 cm at least of greyish Bronze Age deposits; therefore, if a Copper Age feature was indeed overlaid by the Bronze Age 'ashmound', the latter surely destroyed it. Taking this into account, we decided not to continue the trench any deeper and conserved it for future investigations.

Stratigraphy

The following layers were recorded in the northern wall of the trench (Fig. 55):

1. Greyish unconsolidated arable soil with moderate quantity of finds (thickness ca. 35–45 cm);
2. Greyish unconsolidated soil with moderate quantity of finds and charcoal inclusions (investigated thickness 20–91 cm);
3. Dark-brown clayish soil (investigated thickness 14–20 cm);
4. Brownish layer containing lumps of compact trampled earth (investigated thickness 28–38 cm);
5. Light-brown moderately compact soil (investigated thickness 3–12 cm).

Interpretation

Since the trench was not excavated completely, it is complicated to interpret the Late Bronze Age features uncovered in 2019. The Feature 22008 (layer № 3 from the profile drawing) consisting of dark-brown clayish soil seems to be the undisturbed step-surface, in which case the greyish layers which overlie it could actually have been brought from the 'ashmound' by continuous multi-annual ploughing. Under the main 'mound' it appears that the area was intentionally dug to a certain depth from the step-surface (as revealed by the core drilling). The trampled earth layer, its brownish substrate and the small oval pit (posthole?) may be evidence of some kind of construction; the earth could have been trampled by domestic animals and the post could have supported something like a roof. Similar features have been discovered during excavations of other Late Bronze Age 'ashmounds' from Northern Moldova.

As regards the possible Copper Age trackway, the trench unfortunately did not provide any consistent data which would prove or dismiss its existence. The find of a Trypillia shard at Level 4 could be an argument in favour of a Copper Age dating for the linear anomaly; however, this pottery fragment could have been brought to the river by other means. What seems certain is that the Bronze Age 'ashmounds' disturbed the linear anomaly; its exact dating and configuration should be investigated in the future, on a segment outside the Late Bronze Age settlement.

Finds

Although reduced in size, Trench 22 provided a substantial assemblage of Late Bronze Age pottery, animal bones and single finds. The assemblage of pottery consists of around 2500 fragments, and it belongs mostly to the category of coarse ware. Most of the small finds are represented by flint items. There are around 70 fragments, most of them waste and flakes made of local raw material. Among the bone tools, arrowheads are the most common. The discovery of a notched scapula and the fragment of an ice skate with several perforations, which are representative items of this period is worthy of mention. Additionally, a bronze awl was found.

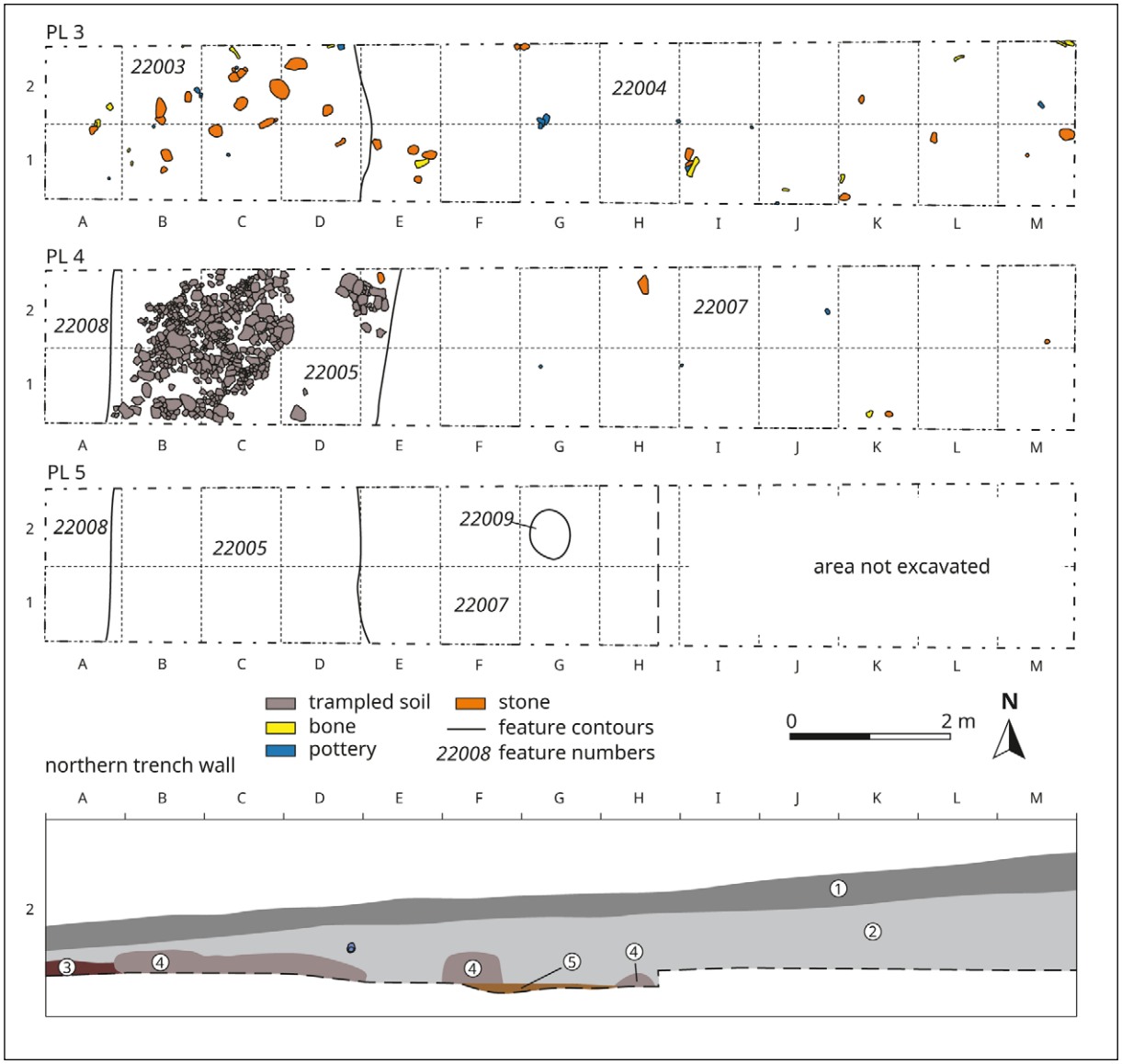


Figure 55. Trench 22, Plana 3–5 and the northern profile of the trench (graphic: S. Ţerna). Numbering of layers on the profile corresponds to those in the text.



Figure 56. Late Bronze Age bone artefacts from Trench 22 (photos: A. Heitmann). Scale 1:1.

Conclusions

The systematic excavation of the four household pits at Stolniceni was a first attempt to address the problem of the socio-economic structure of a Trypillian mega-site from the perspective of targeted investigation of dug-out features. Taken as a whole, the results obtained turned out to be more than successful. The examination of the stratigraphy of the pits allowed us to discern common structural elements which may be assigned to distinct chronological events and linked to the biography of the dwelling located nearby. At the same time, each pit displayed its own peculiarities and biography; it is striking that in three cases we could identify features that were dug out after the activities at the main pits ended; this is a strong argument for a longer existence of a mega-site, earlier postulated based on radiocarbon sequences.

Since all of the four dwellings belonged to different size-classes, we now have at our disposal a unique archive of finds and samples which characterises in multiple ways both residential and communal/integrative constructions. In quantitative terms, the finds acquired from the four pits outnumber by far the materials recovered during extensive excavations in previous campaigns, on other feature types. Future processing and assessment of this materials will offer an extremely detailed and well-grounded insight into the socio-economic life of the Trypillia communities.

Indeed, every pit is a 'chamber full of proxies'.

The small excavations on the Late Bronze Age settlement did not result, unfortunately, in the uncovering of the presumed Copper Age trackway. On the contrary, it has been established that the Bronze Age depositions are most likely to have destroyed it completely. The possible track should be investigated in another spot. Nevertheless, despite reduced excavations, the trench yielded rich Late Bronze Age material and samples for scientific investigations.

References

Balabina 1997: Балабина, В.И., 1997. Фигурки животных и их символика на сосудах как отражение одной из знаковых систем древних земледельцев Европы. Российская археология, 2, 29–45.

Balabina 1998: Балабина, В.И., 1998. Фигурки животных в пластике Кукутень-Триполья. Москва: Российская Академия Наук, Институт Археологии.

Dudkin and Videiko 2009: Дудкін, В. and Відейко, М., 2009. Архітектура Трипільської цивілізації від поселень до протоміст. Київ: Мислене древо.

Gaydarska, B., Nebbia, M. and Chapman, J., 2019. Trypillia Megasites in Context: Independent Urban Development in Chalcolithic Eastern Europe. *Cambridge Archaeological Journal*, 30 (1), 97–121. Available from: DOI:10.1017/S0959774319000301

Hofmann, R., Müller, J., Shatilo, L., Videiko, M., Ohlrau, R., Rud, V., Burdo, N., Dal Corso, M., Dreibrodt, S. and Kirleis, W., 2019. Governing Tripolye: Integrative architecture in Tripolye settlements. *PLoS ONE*, 14 (9), e0222243. Available from: DOI:10.1371/journal.pone.0222243

Müller, J., Hofmann, R. and Ohlrau, R., 2016. From Domestic Households to Mega-Structures: Proto-Urbanism? *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE.* Themes in Contemporary Archaeology 2. London, New York: Routledge, 253–268. Available from: DOI:10.4324/9781315630731

Müller, J., Hofmann, R., Ohlrau, R. and Shatilo, M., 2018. The social constitution and political organisation of Tripolye mega-sites: hierarchy and balance. *In*: H. Meller, D. Gronenborn and R. Risch, eds. Überschuss ohne Staat – Politische Formen in der Vorgeschichte. *10. Mitteldeutscher Archäologentag vom 19. bis 21. Oktober 2017 in Halle (Saale) | Surplus without the State – Political Forms in Prehistory. 10th Archaeological Conference of Central Germany, October 19–21,*

2017 in Halle (Saale). Tagungen des Landesmuseums für Vorgeschichte Halle 18. Halle/Saale: Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt – Landesmuseum für Vorgeschichte, 247–262.

Passek 1949: Пассек, Т.С., 1949. Периодизация трипольских поселений *(III–II* тыс. до н.э.*)*. Материалы и исследования по археологии СССР (МИА) 10. Москва, Ленинград: Издательство Академии наук СССР.

Passek and Krichevsky 1946: Пассек, Т.С. and Кричевский, Е.Ю., 1946. Трипольское поселение Коломийщина (опыт реконструкции). КСИИМК 12, 14–22.

Rassmann, K., Mertl, P., Voss, H.-U., Bicbaev, V., Popa, A. and Musteață, S., 2016. Copper Age settlements in Moldova: Insights into a Complex Phenomenon from Recent Geomagnetic Surveys. *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE.* Themes in Contemporary Archaeology 2. London, New York: Routledge, 55–70. Available from: DOI:10.4324/9781315630731

Rud, V., Hofmann, R., Kosakivskyi, V., Zaitseva, O. and Müller, J., 2019. Trypillia Megasites West of the River Southern Buh: Preliminary Results of Bilyi Kamin Site Investigation in 2018. *Journal of Neolithic Archaeology*, 21, 27–60. Available from: DOI:10.12766/jna.2019.2

Ryzhov and Shumova 2013: Рыжов, С. and Шумова, В., 2013. Культовая постройка поселения Коновка-Пуцита и некоторые религиозные представления трипольского населения Пруто-Днестровского региона. *Revista Arheologică*, IX (1), 64–71.

Scholz, R., Rassmann, K. and Țerna, S., 2018. Stolniceni, Petreni, Brînzeni, Republik Moldau. Luftbildaufnahmen mit Drohnen (UAV) von kupferzeitlichen Siedlungen in Moldawien im Kontext magnetischer Prospektionen und Ausgrabungen. Die Arbeiten der Jahre 2009 bis 2017. *e-Forschungsberichte*, 1, 76–83. Available from: https://publications.dainst.org/journals/efb/2116/6456

Sîrbu, M. and Țerna, S., 2017. Stolniceni II – o nouă așezare cu „cenușare" descoperită în zona de nord a Republicii Moldova. *Tyragetia, serie nouă*, 11 [26] (1), 93–106. Available from: https://oaji.net/articles/2017/4586-1512998786.pdf

Țerna, S., 2016. Geomagnetic surveys of the Neolithic and the Copper Age sites from the Republic of Moldova (1968-2016): main results, current state and future perspectives. *Raport*, 11, 189–225.

Țerna, S., 2021. How can we investigate the socio-economic structure of the Cucuteni-Tripolye mega-sites? Houses as Snapshots and Pits as Durable Narratives. *Archäologisches Korrespondenzblatt*, 51 (1), 37–60. Available from: DOI:10.11588/ak.2021.1.86862

Țerna *et al.* 2017: Церна, С., Рассманн, К. and Рудь, В., 2017. Гончарный горн с позднетрипольского поселения Столничень I (Единецкий район, Республика Молдова) и производство керамики к востоку от Карпат в 4-м тысячелетии до н.э. *Stratum Plus*, 2017 (2), 301–330.

Țerna, S., Vornicu-Țerna, A. and Rassmann, K., 2018. New data on the formation of complex sites in the Western area of the Cucuteni-Tripolye culture. *In*: И.В. Бруяко, Л.В. Носова and Л.Ю. Полищук, eds. Народи і культури нижнього дунаю в давнину. Матеріали Міжнародної науково-практичної конференції (м. Ізмаїл, 23-26 серпня 2018 р.). Ізмаїл: Одеський Археологічний Музей НАН України, Міністерство Освіти і Науки України Ізмаїльський Державний Гуманітарний Університет, 15–25.

Țerna, S., Vornicu-Țerna, A., Hofmann, R., Dal Corso, M., Shatilo, L., Vasilache-Curoşu, M., Rud, V., Knapp, H., Kirleis, W., Rassmann, K. and Müller, J., 2019. Stolniceni – Excavation results from the 2017 campaign. *Journal of Neolithic Archaeology*, 21, 209–282. Available from: DOI:10.12766/jna.2019.9

Uhl, R., 2018. Von Tonstiften und Tokens. Betrachtung einer enigmatischen Objektgruppe im Nordpontus. *Revista Arheologic*ă, XIV (2), 5–12.

Videiko, M. and Rassmann, K., 2016. Research on Different Scales: 120 Years of Trypillian Large Sites Research. *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE.* Themes in Contemporary Archaeology 2. London, New York: Routledge, 17–28. Available from: DOI: 10.4324/9781315630731

17. Putinești 3 and Trinca-*La Șanț*: archaeomagnetic investigation of middle and late Trypillia settlements in Moldova

Robert Hofmann, Stanislav Țerna†, Liudmyla Shatilo, Vitalii Rud, Ghenadie Sîrbu

Introduction

During the investigations of late Trypillian settlements in the Cunicea micro-region (Chapter 18, this work, Vol. II) in spring 2016, there was also the opportunity to investigate archaeomagnetically[1] some settlements of other Trypillian periods in other parts of Moldova. These surveys were embedded within the much broader and longer-term cooperative effort of Kiel University, the Eurasia Department and the Roman-Germanic Commission of the German Archaeological Institute, and numerous regional and international partners, to improve understanding of the temporal and spatial variability of Neolithic and Copper Age settlement behaviour in south-eastern and eastern Europe, and to interrogate them with regard to historical processes (*e.g.* Mischka 2009; Mischka 2012; Müller *et al.* 2013; Chapman *et al.* 2014; Rassmann *et al.* 2014; Müller *et al.* 2016; Uhl *et al.* 2017; Hofmann *et al.* 2016; Müller *et al.* 2017). In this campaign we decided to explore sites located on natural promontories as representing one prominent settlement pattern. This type of topography was used only for a limited number of settlements, in certain phases and regions (*e.g.* Manzura 2005, 318).

In our research we focused in particular on the question of the intra-site spatial organisation and layouts of such settlements in order to explore how they compare

1 Due to his tragic accidental death, Stanislav Țerna unfortunately did not live to see the completion of this article. Since he initiated the fieldwork together with the first author and made a substantial contribution of images and text, we are able to retain his co-authorship. We hope to have completed the paper in a manner with which he would agree.

to well-known Trypillia settlements of the type with concentric layout seen in other regions (Dudkin 1978; Rassmann *et al.* 2014; Țerna *et al.* 2018; Ohlrau and Rud 2019), and on a broader scale to circular layouts of other southeast-European settlements (Mischka 2012; Hofmann *et al.* 2019). Furthermore, we would like to look at how the architecture and size of houses change in processes of population aggregation and dispersal, the extent to which these parameters can be used as proxies for reconstruction of social organisation, and residency rules. Additionally, we would like to investigate how the possible fortificatory characteristics of the investigated settlements might be interpreted in the broader context of corresponding evidence from other Cucuteni-Trypillia sites.

In order to make progress in resolving these issues, the fortified Cucuteni A/Trypillia B1-period settlement of *Putinești 3* was selected from an early phase of the Cucuteni-Trypillia sequence. There, extensive archaeological excavations took place between 1989–1991. It was also surveyed archaeomagnetically by V. P. Dutkin in 1989. In addition to the investigation of this early settlement, there was also the possibility of calibrating archaeomagnetic measurements on concrete excavation features.

For comparison, we investigated archaeomagnetically the settlement of Trinca-*La Șanț* in northwestern Moldova from a later phase of the Cucuteni B/Trypillia C1 period, which follows chronologically after settlements built in open terrain such as Stolniceni or Petreni. This settlement is located on a prominent rock plateau and potentially initiates a new phase of fortification of settlements.

Methods

For magnetic measurements, SENSYS Sensorik & Systemtechnologie GmbH (Bad Saarow, Germany) MAGNETO® MX V3 Survey System was used that offers analysis in various configurations with up to 16 channels (sensors). During the field work in Moldova the device was installed on a wheeled cart pushed by two persons. At the time when the surveys were performed only 11 sensors were available. In order to analyse at the best possible width only 8 sensors were installed, at intervals of 0.5 m and a total width of 3.5 m. The magnetic device was coupled with a GPS system (Leica, GNSS/GPS systems Viva GS 10) enabling continuous grid measurements (zig-zag) in a small amount of time.

No measurement points were available in all surveyed locations which could be used to locate the measurements precisely within the national and world coordinate system. Therefore, in each case it was necessary to establish local measurement systems with the available Differential GPS System Leica, GNSS/GPS systems Viva GS 10. Using this method, our measurements were located in the world coordinate system with a precision of several metres. In order to ensure the possibility of reconstructing the measurement system, fixed points were established and documented. The measurements themselves were performed in UTM coordinate system (zone 35N) and WGS 84 ellipsoid.

Data acquisition, primary data processing, interpolation and export were performed using the SENSYS software package MonMX (v. 4.0), DLMGPS (v. 4.01) and MAGNETO®-ARCH (V3). During export from DLMGPS, automatic track offset correction was enabled. For data export from MAGNETO ARCH we chose the format Surfer grid 7 which delivers raster maps which can be used in GIS applications, enabling the modification of thresholds and colour scale. The standard setting was used which interpolates the measurement results to 0.2 m x 0.2 m raster cells.

For analysis of the geomagnetic maps the GIS application QGIS was used. We carried out the interpretation of the geomagnetic maps in two different ways. On the one hand, anomalies which could be interpreted more or less confidently such as (linear) ditches, (rectangular) remains of burnt houses, or modern disturbances

(*e.g.* from power poles) were interpreted and redrawn directly. On the other hand, an automatic classification of the features was carried out in order to interpret also anomalies of less obvious character. Therefore, vector polygons were generated using the threshold value of 2 nT and the GRASS algorithm *r.contour* level based on the raster grid. For these vector objects different statistical values of average, mean and maximum flux density were calculated. To present the data we choose the median or maximum nT-values.

Putinești 3

Location and history of research

The settlement Putinești 3 is located in the Florești district of Northern Moldova, on the right bank of the River Cubolta, a tributary of the River Raut, Dniester basin, on a triangular promontory built by the confluence of the river with a small brook, near the Bălți-Florești road (Fig. 1). The northern part of the site is damaged by erosion resulting from stone extraction in a quarry. The promontory, although not very high, is naturally protected from the North, NE and NW sides by its moderately steep slopes (Fig. 2).

The site was discovered in 1955 by V. Markevich (1973, 107). Archaeological investigations, led by V. Sorochin, started in 1989 and were preceded by a geophysical survey performed by V. Dudkin (Kiev). Subsequent excavations comprised three campaigns (1989–1991) and resulted in the unveiling of seven above-ground burnt houses and one 'pit-house' on a total area of 851 m^2.

The analysis of the finds (above all, the large pottery assemblage) allowed V. Sorochin to date the settlement to the end of the Cucuteni A/Trypillia B1 stage and to include it in the regional aspect 'Drăgușeni-Jura'. The details of earlier excavations remain unpublished, except for some general information on the settlement, its architecture and inventory in Sorochin's regional synthesis on the Drăgușeni-Jura sites (Sorochin 2002). Thus, the main information on the excavations and finds is contained in the excavation reports stored in the Archive of the National Museum of History of Moldova (Sorochin 1990; Sorochin 1991; Sorochin 1992).

Despite the insufficient degree of publication, the Putinești III settlement may be considered as one of the most important excavated Cucuteni A sites from the Prut-Dniester interfluve, since it contains the largest number of investigated houses and provided a huge collection of artefacts. Moreover, it benefited from various multidisciplinary research work such as the 1988 geophysics, ^{14}C datings, detailed accounts of stone and bone tools, as well as archaeobotanical determinations (Sorochin 2002; Lazarovici 2010).

Dudkin's geophysical survey

The 1989 prospection covered an area of 7 ha (Dudkin and Videiko 2009; cf. Sorochin 1993). It has been established that the site had circa 5 ha and contained about 80 anomalies of varying amplitude coming mainly from burnt houses arranged in rows which form several rectangular or oval 'residential quarters' (according to Dudkin and Videiko 2009). These 'quarters' would include about 10–15 buildings on the perimeter and, in some cases, 1 or 2 buildings in the centre (Fig. 3).

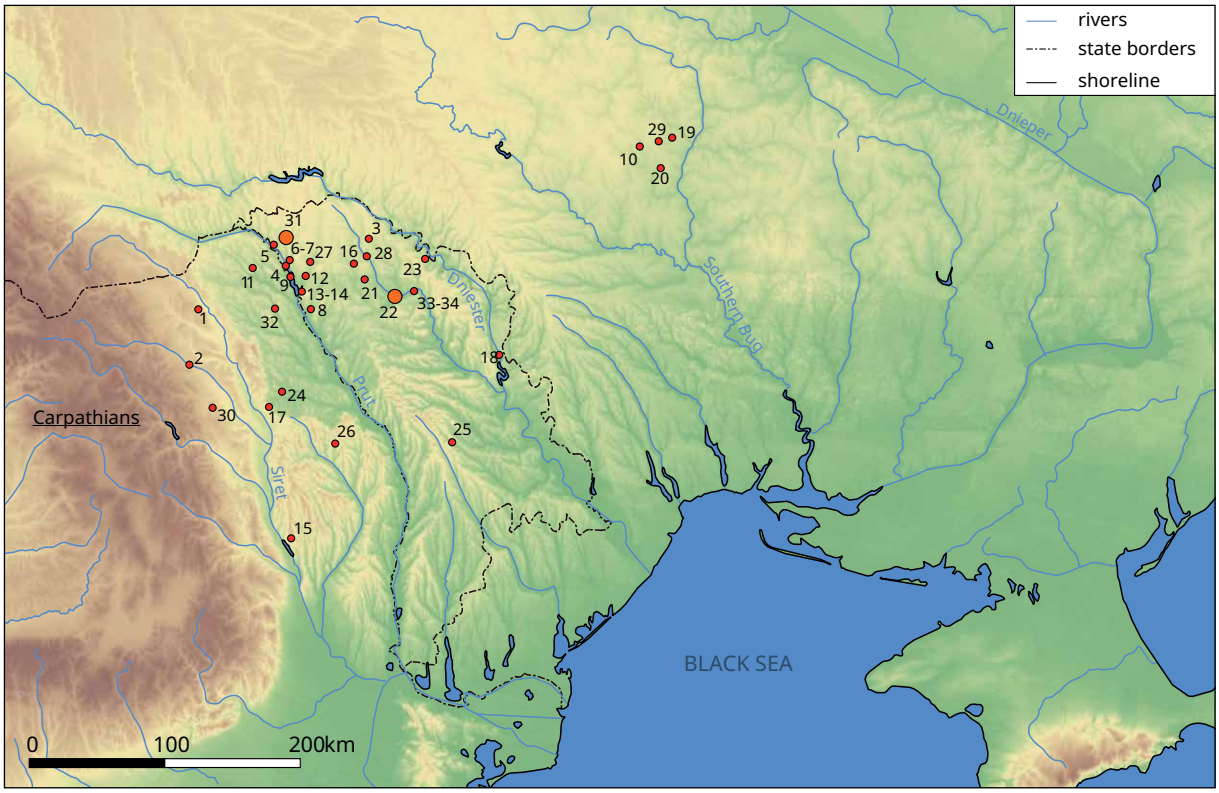


Figure 1. Map of sites mentioned in text (alphabetical order; larger circles mark the prospected sites presented in this article). 1. Adâncata-Dealul Lipovanului*; 2. Baia*-În Muchie*; 3. Bădiceni; 4. Bădragii Vechi; 5. Bogdănești; 6. Brînzeni 4; 7. Brînzeni 8; 8. Cobani; 9. Cuconeștii Vechi 1; 10. Dobrovody; 11. Drăgușeni*-Ostrov*; 12. Druța I; 13. Duruitoarea Nouă 1; 14. Duruitoarea Veche 1; 15. Fulgeriș*-La Trei Cireși*; 16. Glavan 1; 17. Hăbășești*-Holm*; 18. Jora de Sus; 19. Maidanetske; 20. Nebelivka; 21. Petreni; 22. Putinești 3; 23. Racovăț; 24. Războieni*-Dealul Mare*; 25. Ruseștii Noi 1; 26. Scânteia*-Dealul Bodești*; 27. Stolniceni 1; 28. Șuri 1; 29. Talianki; 30. Târpești*-Râpa lui Bodai*; 31. Trinca*-La Șanț*; 32. Trușești*-Țuguieta*; 33. Vărvăreuca 8; 34. Vărvăreuca 15 (map: S. Țerna).*

^{14}C dating

Six ^{14}C dates are currently available from Putinești 3, which allow a relatively reliable absolute dating of the site (Tab. 1). In the following analysis of these data, the two conventional dates of the Kiev laboratory were excluded, since they show very high standard deviations and datings of the Kiev laboratory have generally yielded very inconsistent results (cf. Harper 2013). The exclusion of these dates is partially compensated by a new dating, Poz-98110, which was obtained within the framework of our research programme on Trypillia settlements (cf. Chapter 19, this work, Vol. II).

In view of the wide distribution of the dates without direct stratigraphic relation, the attempt to narrow the dating range has been performed by means of the function *boundary* using Oxcal software (Tab. 2). Accordingly, with the highest probability the settlement dates to the period between 4400 and 4250 BCE, although a longer duration of between 4500 and 4170 (68.2% probability) or 4700 and 3900 (95.4% probability) cannot be completely excluded.



Figure 2. The settlement of Putinești 3 viewed from the northeast with the Cubolta River in the foreground (photo: R. Hofmann).

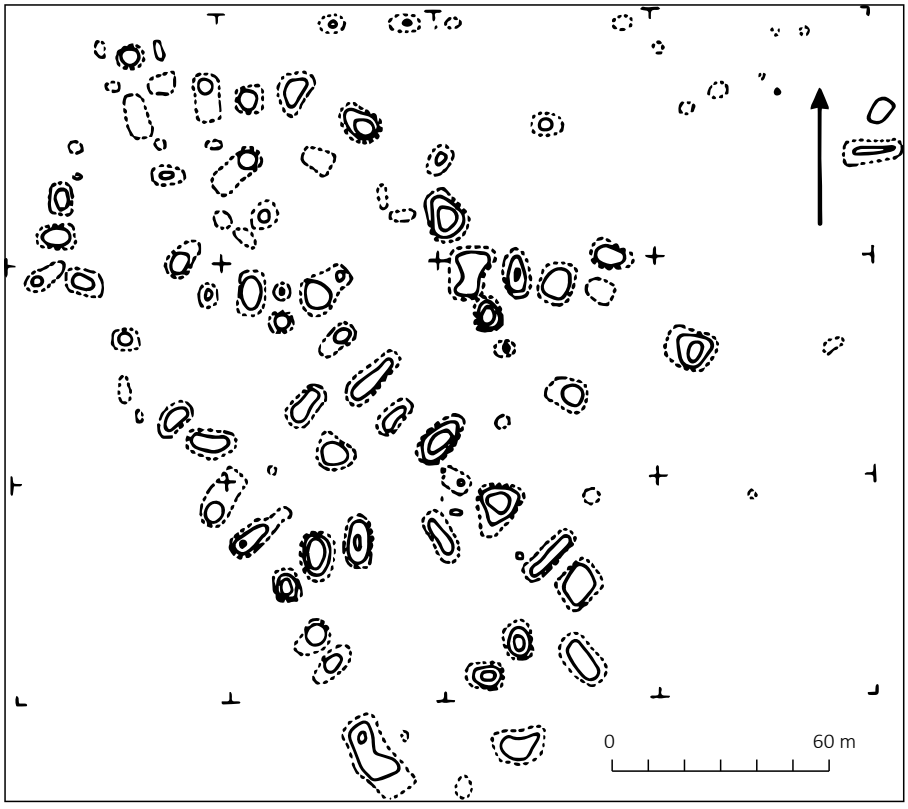


Figure 3. Putinești 3: Magnetic plan by Dutkin.

Laboratory-ID	^{14}C age	Sample material	Context	Reference
Ki-609	4215±110	Unknown	Unknown	Bojadziev 1998
Bln-2447	5595±80	Bone, unknown species	Unknown	Lazarovici 2010
Hd-19441	5379±32	Charcoal, unknown species	Pit House 4, –2 m	Lazarovici 2010
Lv-2156	5520±70	Charcoal, unknown species	H3, Cassette 3,-1.70 to -1.80 m	Lazarovici 2010
Ki-613	5060±120	Bone, unknown species	Unknown	Telegin *et al.* 2003
Poz-98110	5390±40	Antler tool, *cervus elaphus*	Trench 3, burnt Dwelling 7, Square E11	Chapter 19, this work, Vol. II, Suppl. 1

Table 1 (above). Putinești 3: Available ^{14}C dates.

Table 2. Results of the modelling of ^{14}C dating from Putinești 3 with indication of the different dating probabilities. A_{model}=113.7; $A_{overall}$=109.9. Start and end dates in BCE, span and duration in years.

Event	1-Sigma	2-Sigma	Highest
start	4503 (68.3%) 4320	4736 (95.4%) 4254	4400
span	4–160	0–304	
duration	4 (68.3%) 300	0 (95.2%) 735	
end	4315 (68.3%) 4171	4331 (95.4%) 3912	4250

Magnetic Survey of 2016

Houses and layout of the settlement

In the area of the settlement Putinești 3, a total of 5.71 ha were archaeomagnetically surveyed and the settlement completely recorded (Fig. 4). The settlement is delimited in the south and southeast by a linear anomaly of a single semi-circular ditch, enclosing an area of 4.2 ha. Outside the ditch, only a few small anomalies are visible. Within the enclosed area, numerous highly magnetic anomalies are concentrated especially in the western part, while only isolated and much weaker anomalies are visible in the north-eastern third of the plateau.

Anomalies of at least 73 burnt houses, rectangular in shape, are visible mainly in the north-western part of the plateau. Regarding the maximum intensity of the anomalies, numerous gradations can be observed of between 5 and 50 nT (Fig. 5). The majority of anomalies show maximum flux densities of up to 25 nT. More rarely, there are stronger signals in the range between 25 and 50 nT. Values above 50 nT occur only occasionally in very small areas.

The floor area of the houses varies between 48 m² and 185 m², with a median of 92 m² (Fig. 6). The houses have lengths of between 8.8 m and 19.7 m (median 13.7 m) and widths of between 5.1 m and 9.6 m (median 6.8 m). The median length-width index is 2, so that the houses are generally about twice as long as they are wide.

In the majority of cases the house anomalies do not show magnetisation over their entire surface area. Rather, there are often particularly highly magnetic zones along the outer walls and lower magnetisation inside the house areas. The latter probably originates from inwardly-collapsed walls. Comparable massive daub packages from platforms, regularly found in the *ploshchadki* of central Ukraine, are absent at Putinești 3 (cf. Sorochin 2002).

In the case of at least 26 house anomalies, areas of lower magnetisation are evident on one short side of the house anomalies, which is likely to be due to less massive built entrance areas with vestibules (Fig. 7). These areas are between 2.5 m and 5.2 m long and comprise about a quarter of the total length of the houses. A division of the houses into an anteroom and a main room, which is also a characteristic of Trypillia houses in other regions, is recognisable on the anomalies (Chernovol 2012). In Maidanetske, the majority of corresponding areas are located on the street side of the houses, while pits mark the area at the back of the houses (Pickartz 2019).

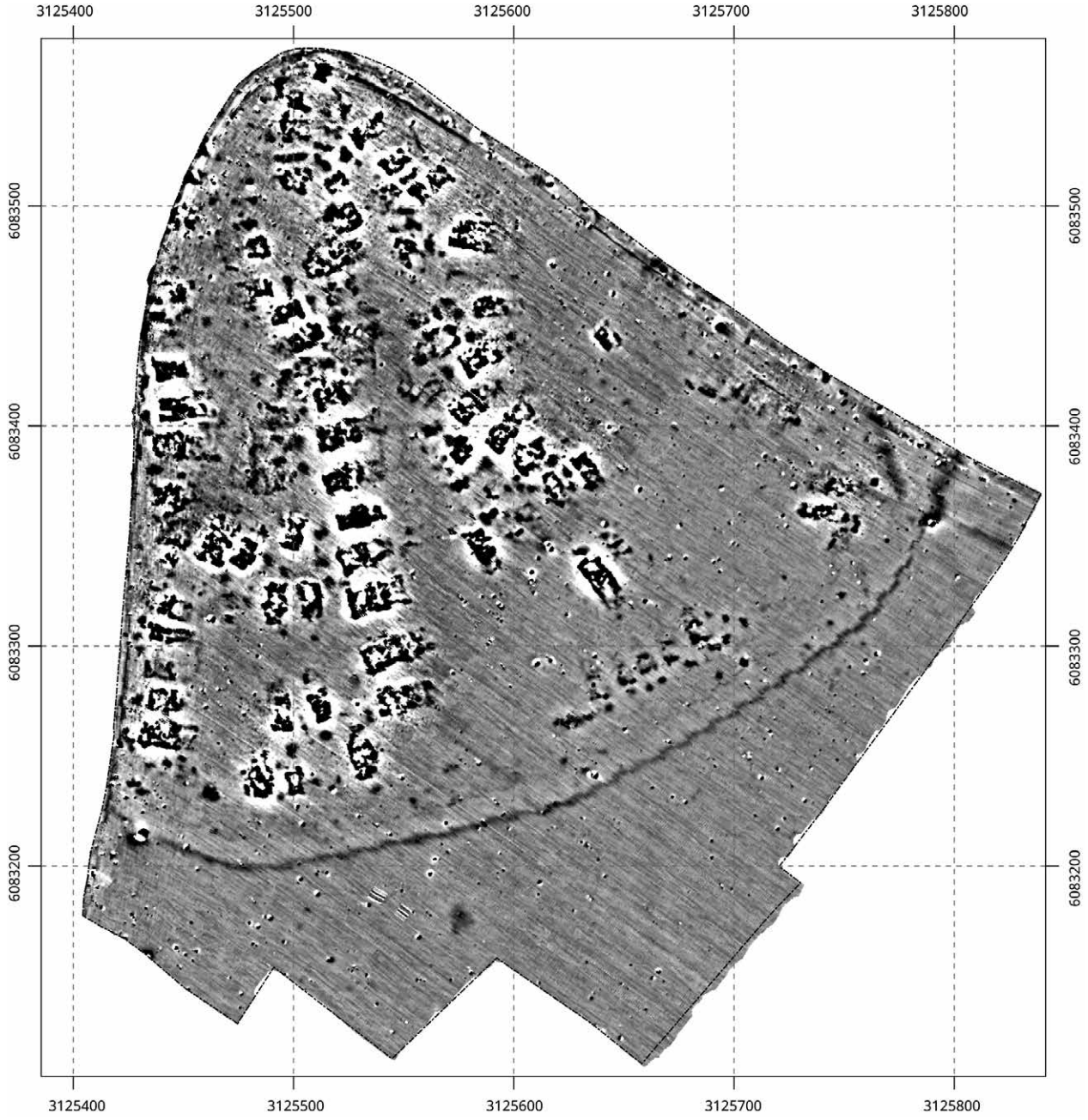


Figure 4. Putinești 3: High resolution magnetic plan, 2016 (graphic: R. Hofmann).

The house anomalies in Putinești 3 form three to four partly irregular rows, which run in a south-north to northwest-southeast direction radially towards the end point of the promontory and vary in their orientation between E-W and NE-SW. Perpendicular to this, shorter concentric rows of two to five N-S to NW-SE oriented houses run partly between the radial rows of houses and partly at intervals of about 20 m parallel to the ditch of the settlement. In the centre of the settlement they seem to enclose a small plaza, tending to be rectangular, in the centre of which there are also one or two buildings.

The orientation of the houses varies within the settlement considerably in places (Fig. 8). Radially arranged houses show orientations between E-W and NE-SW. The orientations of concentrically arranged buildings vary between NNE-SSW and NW-SE. Since the settlement is oriented toward the end point of the promontory, the

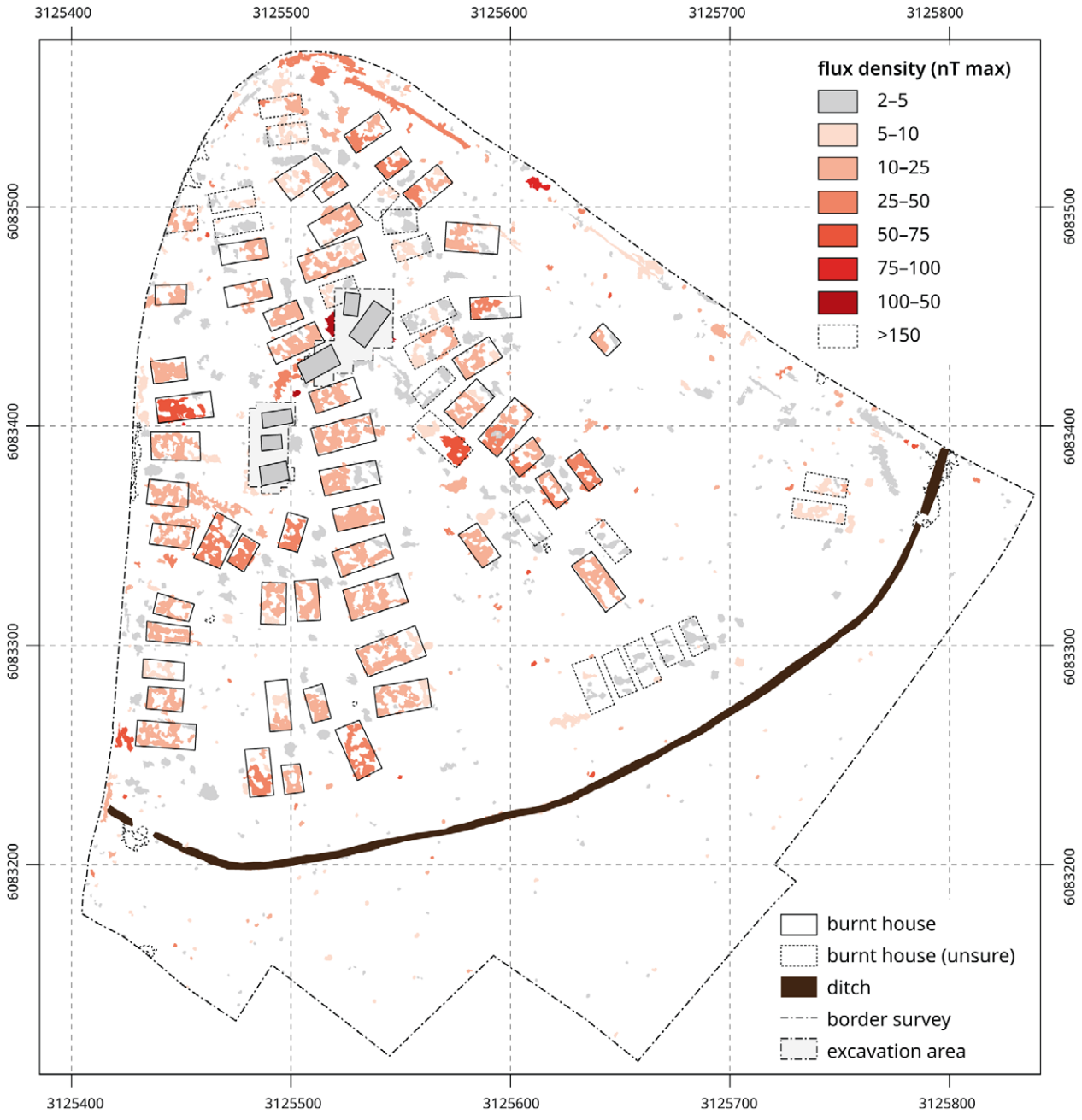
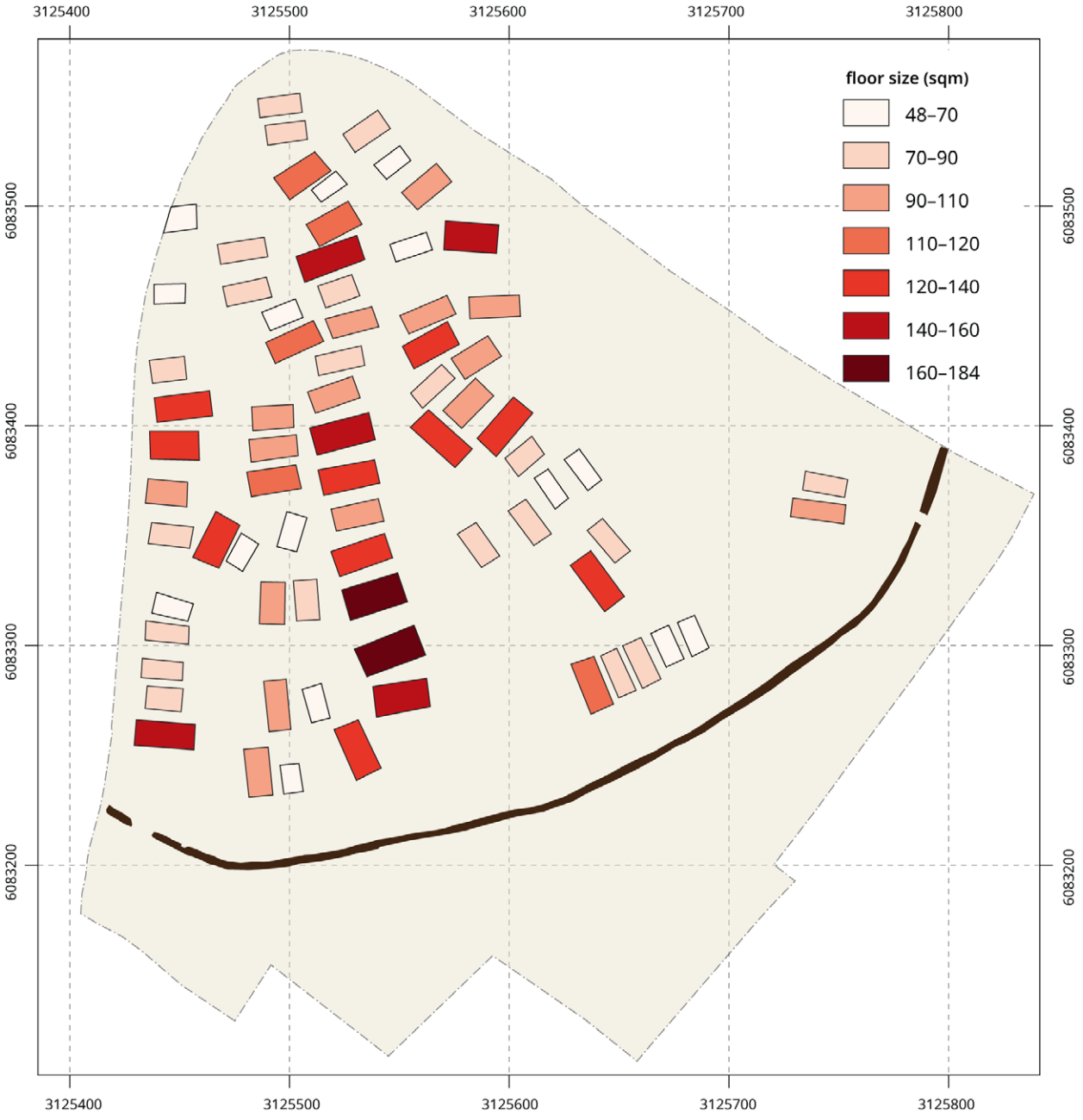


Figure 5. Putinești 3: Automatic classification of the maximum magnetisation of polygons generated based on 2 nT isolines. Overlaid upon this is the interpretation of the anomalies (graphic: R. Hofmann).

orientation of individual houses depends on to which radial row or concentric row segment it belongs. Beyond these conditionalities that are based on the layout of the settlement, different types of deviations can be observed. 1) Within the same row, there are fine-scale variations between adjacent houses. 2) In certain parts of the settlement, there exist groups of houses that show deviating orientations compared to their surroundings. E-W and ENE-WSW oriented houses tend to be part of regular rows. In contrast, slightly more NE-SW oriented houses tend to belong to irregular groups and are not so clearly part of longer rows.

Compared to other areas of the settlement, the central or second house row from the west is particularly regular in structure and contains especially large houses in the south-eastern part. This regular arrangement contrasts strongly with irregularly structured areas such as east of this row of houses and in the north of the settlement.



Here, neighbouring houses show very different orientations and are sometimes very close to each other.

Based on the location of house areas with lower magnetisation, it is possible in many cases to reconstruct the location of the house entrances (Fig. 9). Thus, in the majority of radially arranged houses, the entrance was located on the eastern or north-eastern side. Deviations from this are seen, for example, in the northern part of the central second radial row of houses (counting from the west), where we observe a sudden change of the entrance direction to the west. This correlates with a splitting of this row of houses into two parallel strands. Also, in concentrically arranged groups of houses, the arrangement of the entrances is inconsistent: while in the west of the settlement the entrances are located in the north, further east they seem to be located rather in the south.

Figure 6. Putinești 3: Interpretation of the magnetic plan displaying the size of houses (graphic: R. Hofmann).

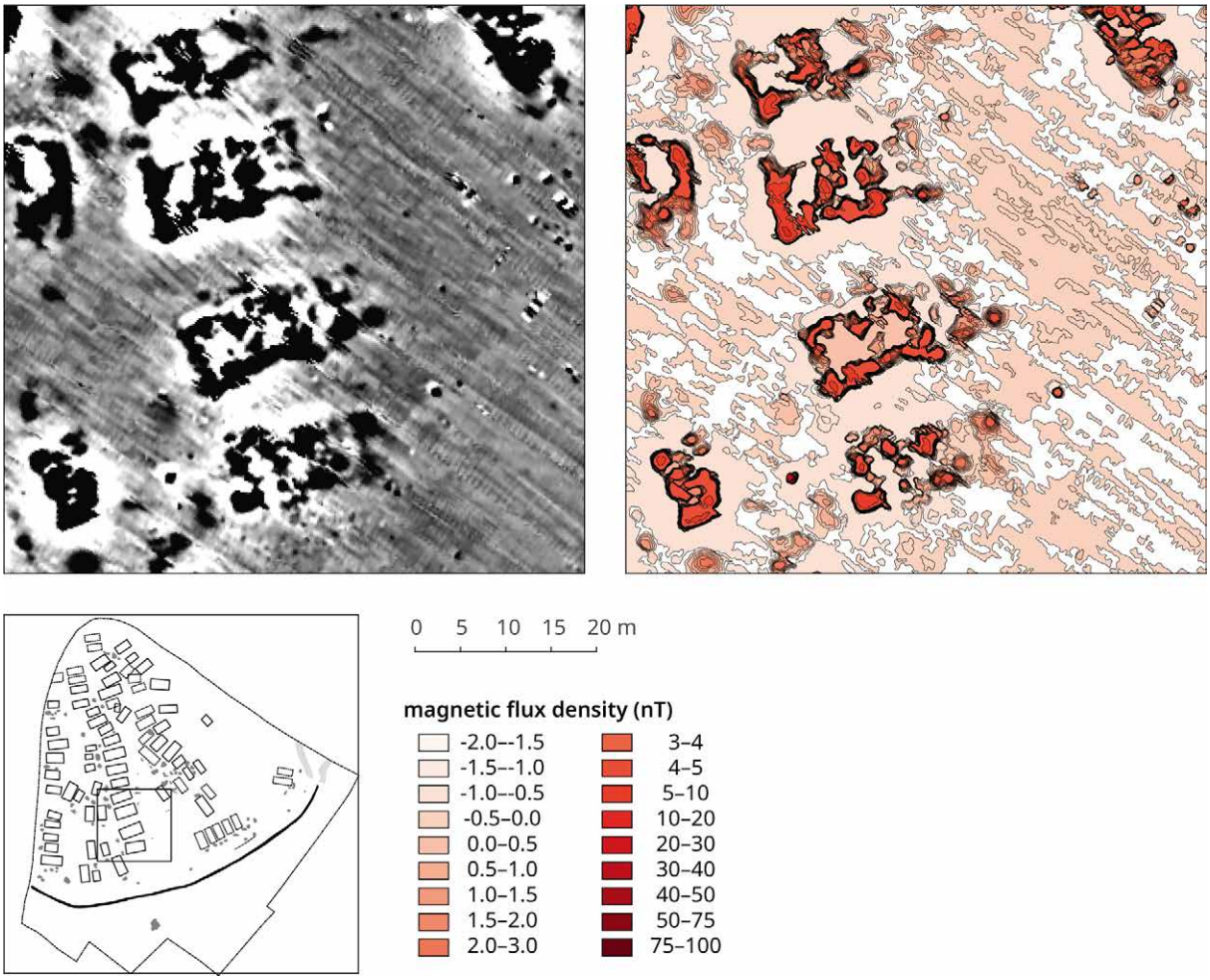


Figure 7. Putinești 3: Detailed view of typical magnetisation patterns of burnt houses with a highly magnetised main room and a less magnetised entrance area (graphic: R. Hofmann).

Fortification

The aforementioned ditch is visible in the magnetic survey image as a relatively weak linear anomaly (Fig. 3). It completely delimits the triangular area of the settlement to the southwest, south and southeast and has no clear interruptions. The ditch has a total length of about 300 m and a width of at least 2 m. To the northeast, the ditch connects to a short erosion channel that continues to the Cubolta River bank. In contrast, to the west it extends to slope of the adjacent stream valley.

On the interior side, the ditch is preceded by a 7–8 m wide zone, which is somewhat quieter and more undisturbed than the adjacent interior surface of the settlement. On the barely definable border between this zone and the inner surface, there is a thin linear anomaly in the middle part of the ditch, about 1 m wide and 25 m long, which could be the remains of a fence or palisade. Judging from the zone in front of the ditch on the inner face, this boundary may have accompanied the ditch along its entire length.

Summary and remarks on Putinești 3

In Putinești 3, a settlement from the second half of the 5th millennium BCE (ca. 4400–4250 BCE) was archaeomagnetically investigated. The settlement was fortified through its location on a natural promontory and a ditch-palisade system. With its size of ca. 5 ha, this settlement was rather small compared to other Cucuteni-Trypillia settlements, especially given that the area enclosed by the terrace slope

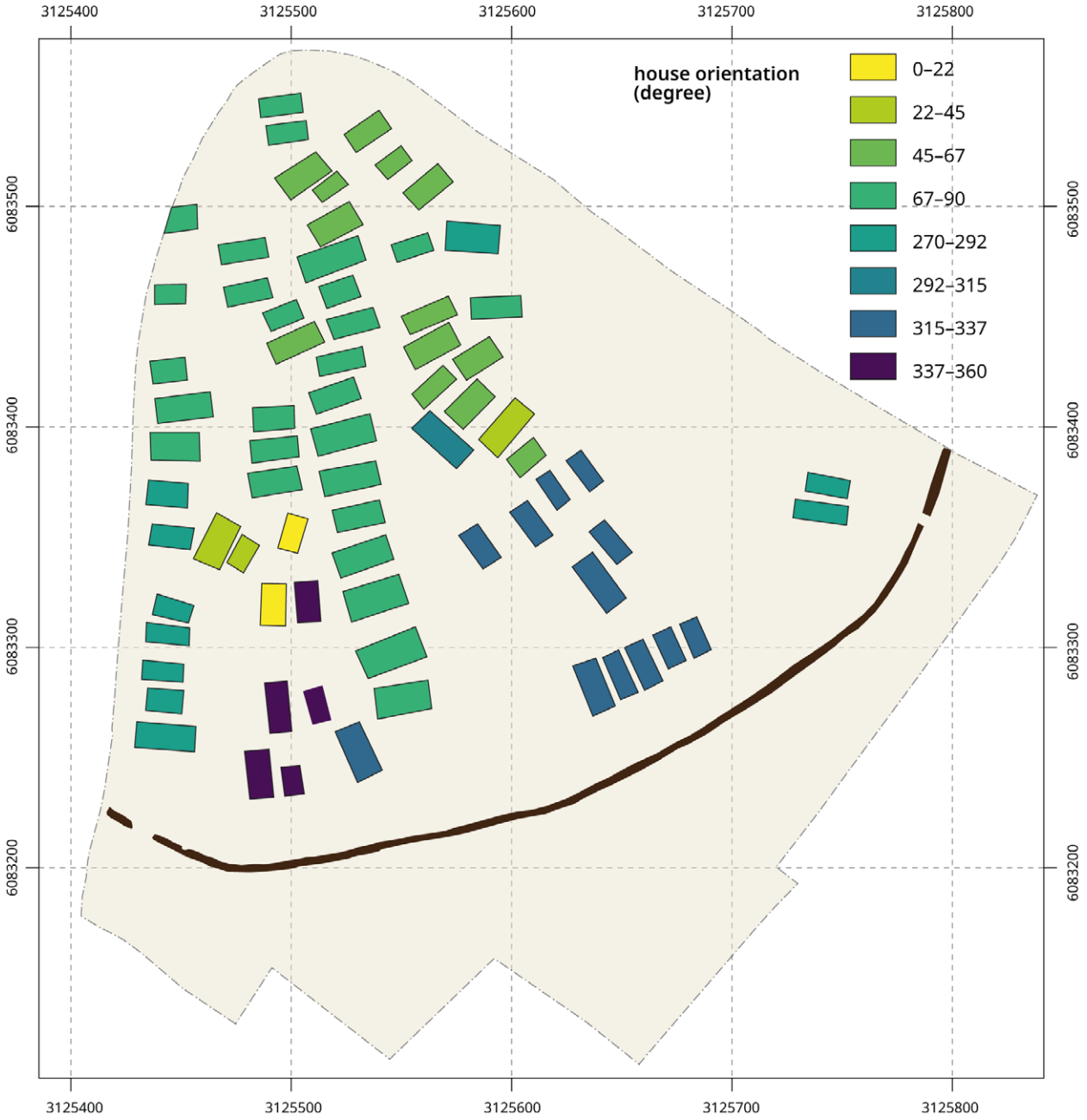


Figure 8. Putinești 3: Interpretation of the magnetic plan displaying the house orientation in degrees starting from the top, in clockwise direction (graphic: R. Hofmann).

and the ditch shows houses only in its northern and western parts, while larger unbuilt areas existed in the northeast. This conclusion is made under the premise that no areas existed with unburnt houses and which are therefore not visible in the plan of the magnetic survey.

Considered in the sense of a segment of a circle, whose centre is the northern vertex of the triangular site area, the settlement exhibits a structure consisting of radial house rows and concentrically arranged smaller house groups.

In regional comparisons, Putinești 3 represents an early example of a layout type that existed, with local variations, from the second half of the 5th millennium until at least the first centuries of the 4th millennium BCE (Fig. 10). This type of layout has the following characteristics:

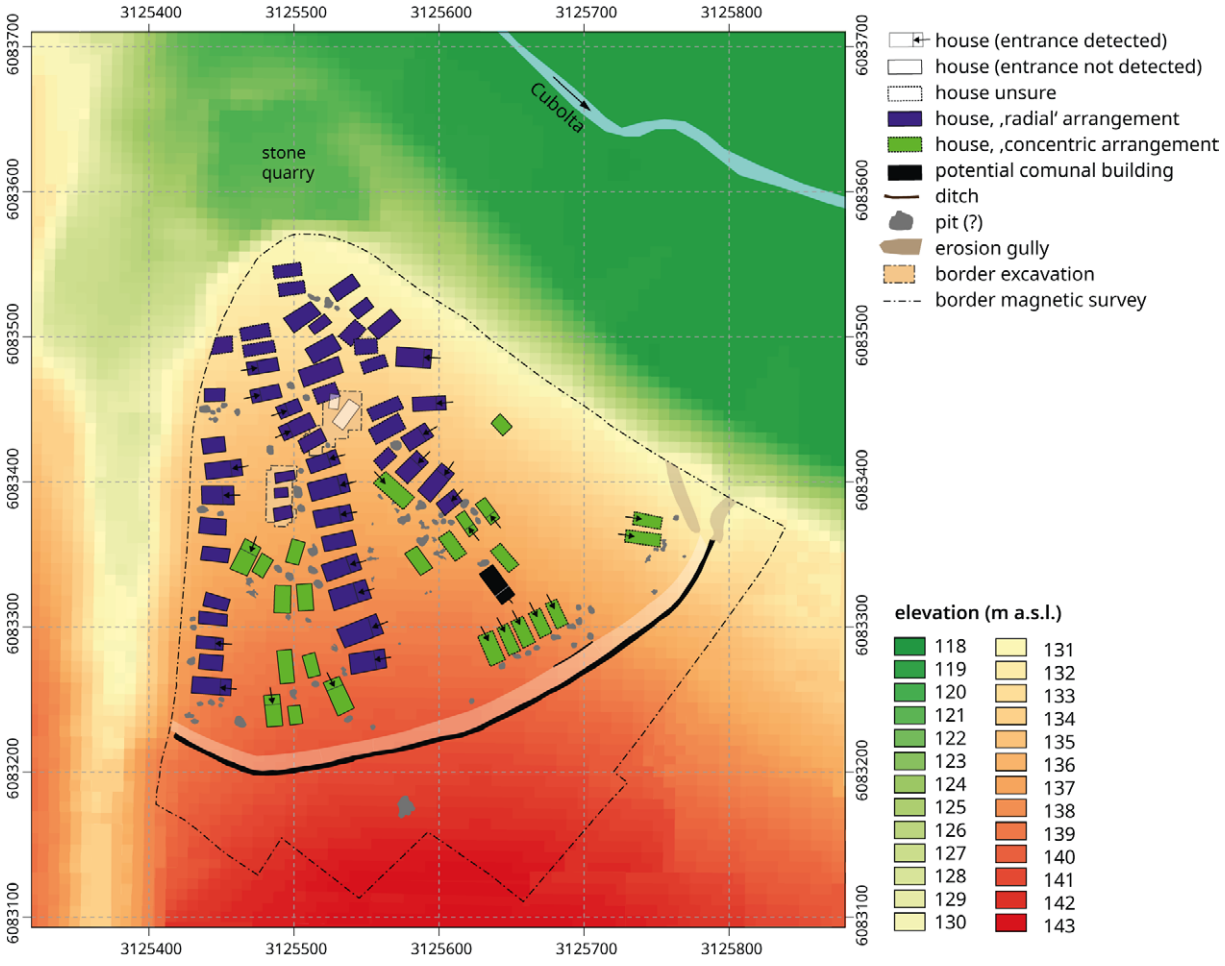


Figure 9. Putinești 3: Interpretation of the magnetic plan illustrating radial (blue) and concentric (green) house alignements, the location of house entrances and a possible communal building (graphic: R. Hofmann).

- position on naturally protected triangular or elongated promontories
- fortification by ditches and/or palisades towards the hinterland
- combination of 'radial' and concentric house rows, partly existing house clusters
- in the contact zone to the hinterland, rectangular or irregularly shaped plazas were often located, where sometimes particularly large buildings – so-called mega-structures – were used for integrative activities
- size between 1.5 and 7 ha with populations of up to about 500 people.

Recently, Andrei Asăndulesei raised the question of the scale at which erosion processes may have caused the reduction of settlements on promontories and altered their original layout. On the basis of erosion rates and analogies to ring-shaped settlement layouts of Trypillia settlements, he tries to show for the Cucuteni settlement of Ripiceni-Holm in Eastern Romania that this settlement originally had a circular layout, which was subsequently only reduced more and more in its structure by lateral erosion of the adjacent river (Asăndulesei *et al.* 2020).

Although such high-scale reductions in the substance of settlements are also quite likely elsewhere (*e.g.* Hofmann *et al.* 2019), it seems questionable to what extent this might be true for all settlements of the Cucuteni type situated on promontories. In the case of Putinești 3, we would tend to disagree with this, since clearly only a part of the plateau was developed here.

In contrast to other more irregularly structured sites, the focus of the settlement layout in Putinești 3 is on 'radial' rows, while concentrically arranged groups



*Figure 10. Settlement plans of Cucuteni A, A/B and B sites, from large-scale excavations or geophysics (graphic: S. Țerna, R. Hofmann). 1. Hăbășești-*Holm *(redrawn after Dumitrescu* et al. *1954); 2. Trușești-*Țuguieta *(redrawn after Petrescu-Dîmboviță* et al. *1999); 3. Războieni-*Dealul Mare *(redrawn after Asăndulesei 2017); 4. Trostianchyk (redrawn after Rud* et al. *2018); 5. Ghelaiești-*Dealul Nedeea *(redrawn after Mischka* et al. *2016).*

of houses are perhaps a secondary component. A central plaza with communal facilities is not really clearly pronounced here, compared to other settlements.

The inconsistent orientation of the houses and the partially very high building density in Putinești 3 are indicators that obviously not all houses existed at the same time. Rather, we have to assume a longer development of the settlement. Clues about the direction of this development can potentially be derived from the alignments of the houses. Under the label *'pseudoneglect'*, it has beenvery recently described how systematic copying errors were unconsciously made when trying to align new houses with existing ones (Müller-Scheeßel *et al.* 2020). These copying errors lead to counterclockwise deviations, which can be used to decipher the intra-site chronology. At the regional level, the surprisingly long persistence of basic house orientations shows that the ideal of uniformly oriented houses apparently lay behind this phenomenon (cf. Hofmann and Müller-Scheeßel 2020).

As applied to the settlement plan of Putinești 3, this would mean that the settlement was founded as two or three parallel rows of houses in the west of the plateau at first. Also, the concentrically arranged groups of houses in the area of the potential plaza and parallel to the ditch could have been established at an early stage. Thus, at the beginning, the settlement seems to have had a rather regular, planned character.

The inconsistent alignment of houses within the radial rows could indicate that they were only gradually infilled, as has recently been demonstrated for the settlement of Talianki (Shatilo 2021, 121–124). The more counterclockwise rotated houses in the north-east of the settlement and a group of houses in the west might be younger.

The proposed intra-site chronology has different implications: 1) The irregular character of the assumed younger buildings could indicate that the systematic and planned character of the settlement became more and more lost in the course of time. 2) In this early phase, the settlement consisted of about 50 houses maximum. If one takes into account the subsequent infilling of the rows, the actual number may have been rather smaller, amounting to only 30–40 houses. If one also takes into account the requirement of 7 m² of floor space per person, derived from a cross-cultural ethnographic sample, and the average size of the main living space of ca. 70 m² (average house size of 92 m² minus 1/4 for the entrance hall), one would have to assume an average of 10 inhabitants per house and a local population of 300–400 persons to begin with. 3) In the later phase of the settlement, a decrease in the number of houses may have taken place. There seems to be a tendency to shift the focus of the settlement to the north-eastern part of the plateau and a separation into several house clusters.

Trinca-*La Șanț*

Location and history of research

The settlement is located on a high trapezoidal promontory which is situated directly to the south-west of the village of Trinca (Edineț district; Fig. 11). The promontory has steep and rocky naturally-protected sides rising ca. 75 m above the valley of the narrow Draghișteț River, a tributary of Racovets River, Prut basin. It consists of two parts – the quasi-triangular northern one and the trapezoidal southern one. The transition between the two constituting sectors is marked by the presence of a massive earthwork (ditch and rampart), clearly seen both with the bare eye and on the aerial photographs. The microzone around the promontory is rich in archaeological sites spanning from the Paleolithic to Middle Ages. At least five other Copper Age settlements have been recorded at various heights in the river's vicinity within an area of 10 km² (Fig. 12; cf. Levițki *et al.* 2016).



*Figure 11. Trinca-*La Șanț*: View from the north of the plateau with the settlement with the valley of the Dragişte River in the foreground (photo: L. Shatilo).*

Trinca-*La Șanț* was discovered in the 1990s by O. Leviţki, who conducted two excavation campaigns in 1999 and 2011, over a total area of 163 m^2 (Leviţki *et al.* 1999; Leviţki and Chitic 2006; Leviţki and Alaiba 2008; Leviţki and Alaiba 2009; Leviţki and Alaiba 2010; Leviţki *et al.* 2013). The investigations were concentrated on the ditch-rampart sector and resulted in the discovery of several distinct features, such as the trapezoidal ditch dug in calcareous stone, a complex rampart with stone foundation, a surface dwelling of burnt daub, a dugout dwelling, agglomerations of finds on the prehistoric step-surface as well as several pits (Fig. 13). Except for the ditch and rampart, all of the features have been assigned to the Copper Age and have been dated to the late-Trypillia period. The excavations yielded a large quantity of finds including pottery (Fig. 13), bone, antler, flint and stone tools, and clay miniatures. The pottery assemblage from Trinca allows it to be included in the Trypillia C1 stage and to be placed chronologically after settlements like Petreni or Stolniceni 1 (Uhl *et al.* 2017; Țerna *et al.* 2019b; Chapter 16, this work, Vol. II).

^{14}C dating

This relative chronological classification is also confirmed by a ^{14}C date obtained in the context of systematic efforts to date Trypillia contexts in the framework of the Collaborative Research Centre 1266 (Tab. 3; Chapter 19, this work, Vol. II). This dating was obtained from cattle teeth recovered from the area of House 1 in Section 2 of the recent excavations (cf. Leviţki *et al.* 2013).

Although the date falls within a relatively long period between 3894–3669 (68.3%) and 3943–3651 (95.4%) due to an extended wiggle of the calibration curve, the highest probability is that it dates between 3800 and 3700 BCE (Fig. 14). Thus, it is clearly younger than the datings from Stolniceni 1 and Petreşti, the majority of which date between 3950 and 3800 BCE (Uhl *et al.* 2017; Țerna *et al.* 2019b; Chapter 19, this work, Vol. II).

Magnetic survey

At the Trinca-*La Șanț* site, a total area of 8.35 ha was archaeomagnetically surveyed, which corresponds to about half of the settlement. The measurements focused on the north-western part of the plateau, which was fully investigated and which is

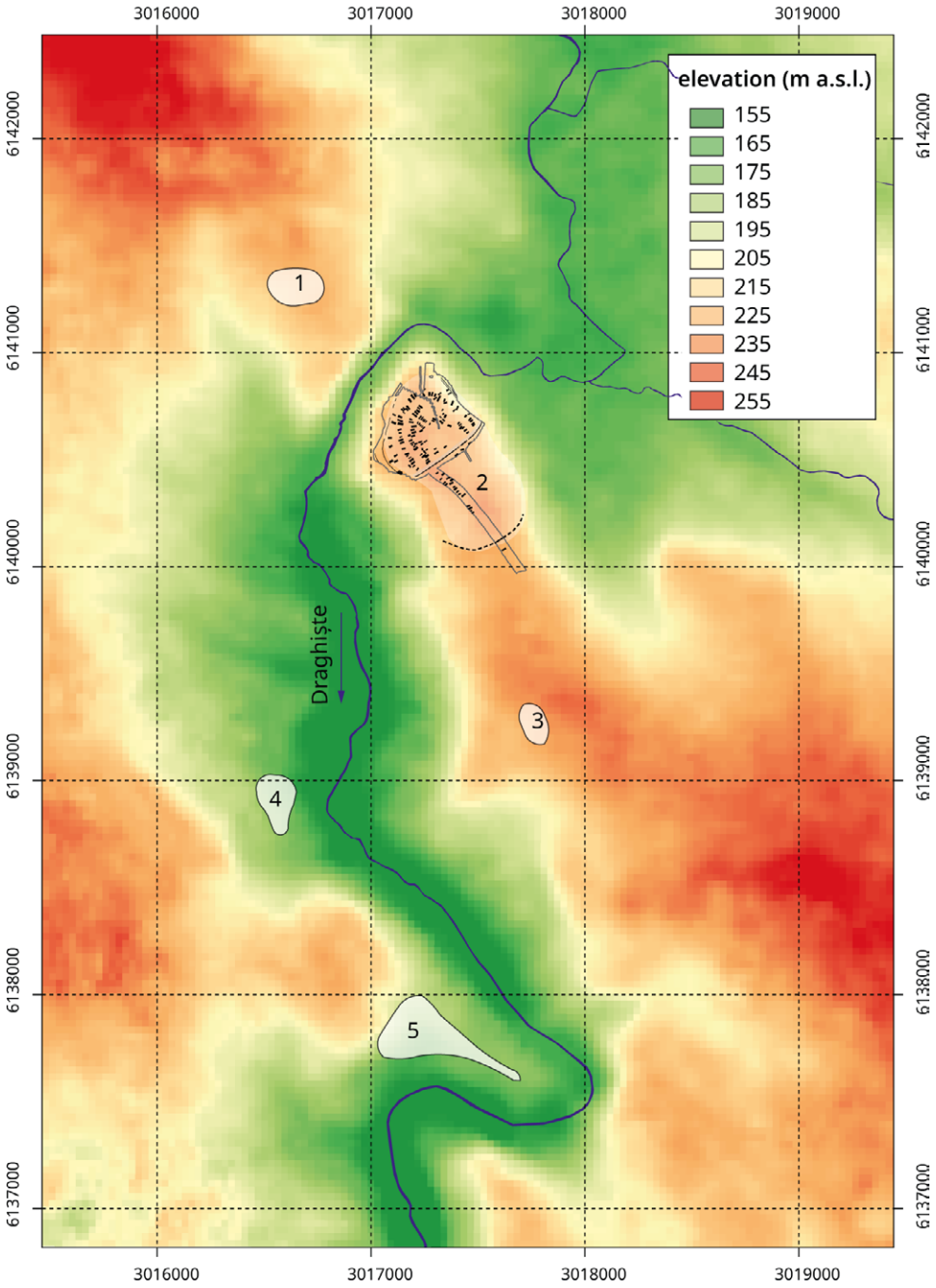


Figure 12. Topographical map of the micro-region Trinca and Trypillia period settlements after Leviţki et al. *2016: 1. Trinca*-Hirtop, *ca. 1 ha, middle Eneolithic, on top of a promontory; 2. Trinca*-La Șanț, *3. Trinca*-La stîna lui Ghicu, *ca. 47–65 ha, middle Eneolithic, on top of a promontory; 4. Trinca*-La vararie, *ca. 3.5 ha, middle Eneolithic, on a slope; 5. Trinca*-Izvorul lui Luca, *ca. 9 ha, Trypillia C2, Gordinești type, on top of a promontory (graphic: R. Hofmann).*



*Figure 13. Trinca-*La Șanț*: The 2011 excavations: 1. General view over the trench; 2. The ditch dug in calcareous stone; 3. Pottery agglomeration under the stone foundation of the rampart; 4. Burnt Copper Age dwelling; 5. Pottery finds from archaeological features (photos: O. Leviţki, G. Sîrbu).*

Laboratory id	^{14}C age	N (%)	C (%)	col (%)	Sample material	Context
Poz-98134	4990±40	1.1	2.1	2.35	bone, *bos taurus*, tooth	Trench 2, Square C6, Dwelling 1, depth: 110 cm

Table 3. Trinca-La Șanț: ^{14}C *sample details.*

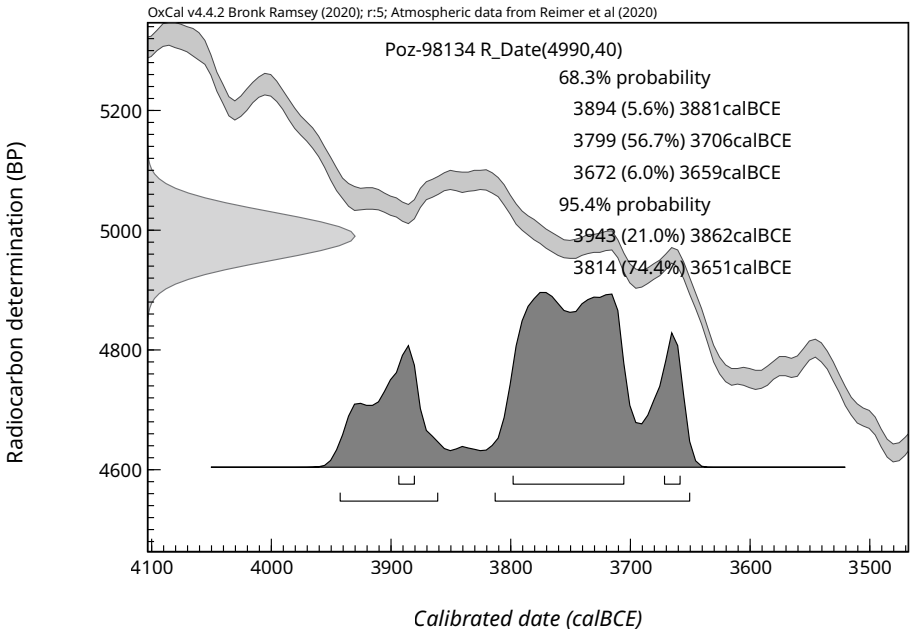


Figure 14. Trinca-La Șanț: *Calibration plot of date Poz-98134.*

separated from the southern part of the plateau by the central rampart ditch system that is still visible on the surface. In addition, with the aim of additionally recording the south-eastern settlement boundary, a 30 m wide and approximately 625 m long section was surveyed south of the central rampart ditch system.

Due to the location of the settlement on a limestone plateau, the image of the magnetic survey is characterised by a very turbulent structure and by numerous 'disturbances' (Fig. 15). While in many cases the location and size of burnt houses can nevertheless be identified relatively easily, in most cases it is not possible to distinguish pits and other anomalies with lower intensity from the geologically-induced background noise. Relatively easy to recognise are only linear anomalies, which potentially originate from features deepened into the limestone and backfilled with humus material.

In the magnetics plan, the anomalies of at least 80 houses were identified with certainty, with floor sizes of between 15 m² and 155 m² (Figs. 16, 17). The median 50% of the data varies between approximately 45 m² and 70 m²; the median size of the houses amounts to 58.5 m² (Appendix 1). In addition, there are at least 80 more houses whose approximate location, size and orientation can be identified in most cases, but whose contours are unclear. Numerous other anomalies, even more difficult to recognise, indicate considerably more houses and a much higher density of the built space.

The arrangement of the houses follows the principle of other ring-shaped Trypillia settlements. Two densely built house rows delimit with their gable ends a 22–25 m wide ring corridor. The zone outside the ring corridor is characterised on the south-western side of the settlements by short, radially arranged rows of houses consisting of a maximum of 7–8 houses each. In contrast, the arrangement of the houses in the northwest and northeast cannot be clearly identified.

The zone within the ring corridor showed a dense building density that left almost no unbuilt space in the centre of the settlement. In the area investigated, parallel rows of houses are visible in two places, probably bordering roads leading radially from



Figure 15. Trinca-La Șanț*: Magnetic plan (graphic: R. Hofmann).*



*Figure 16. Trinca-*La Șanț*: Automatic classification of the median magnetisation of polygons generated based on 2 nT isolines. Overlaid upon this is the interpretation of the anomalies (graphic: R. Hofmann).*

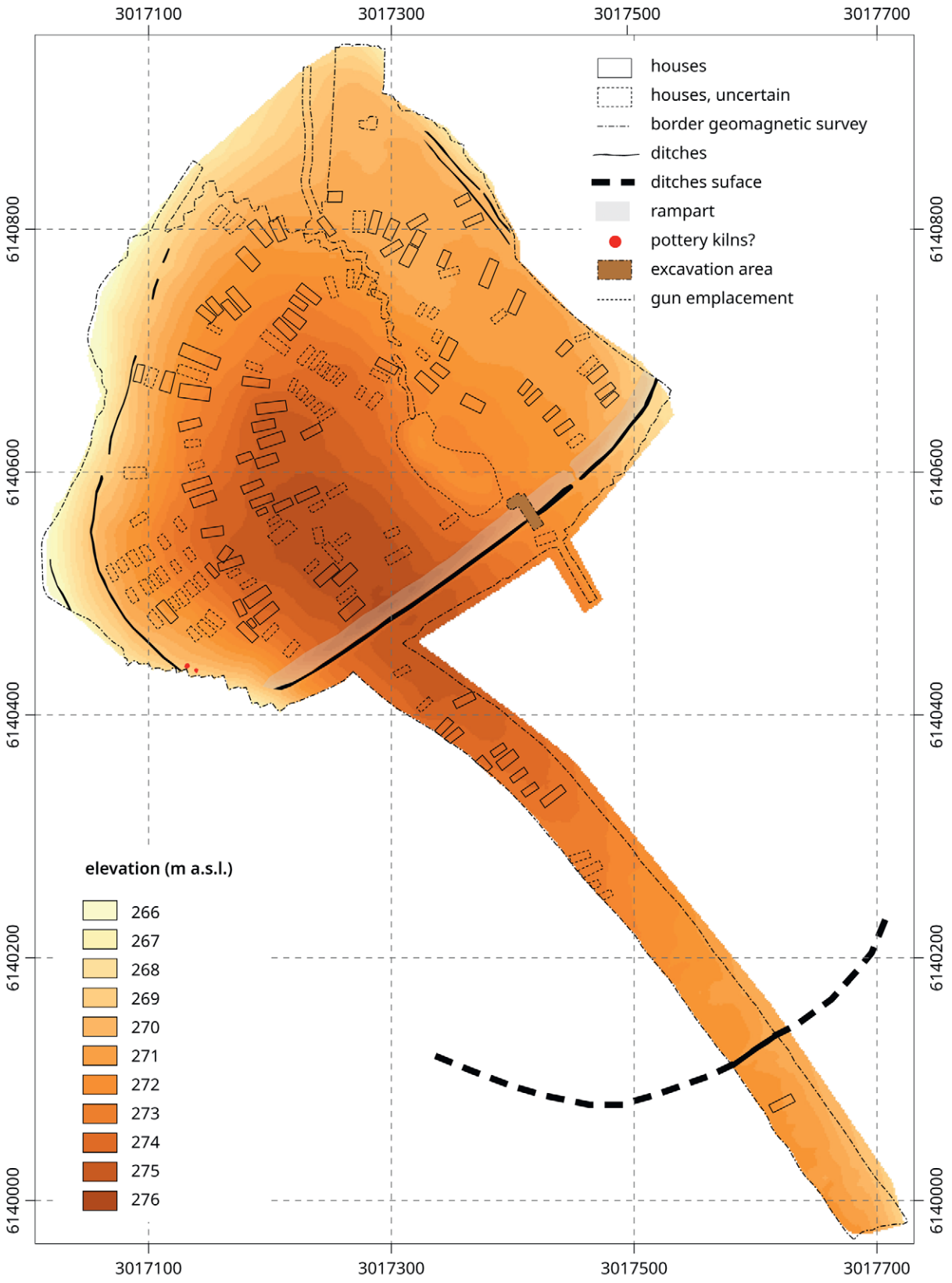


Figure 17. Trinca-La Șanț*: Interpretation of the magnetic plan (graphic: R. Hofmann).*

the ring corridor to the centre of the settlement. Embedded in an overall turbulent structure, there are also concentrically arranged houses in the inner settlement zone.

In the southern part of the settlement, the inner row of the south-western ring corridor of part of the inner settlement zone was surveyed. More detailed findings are unclear because of the limited size of the surveyed area and a possibly irregular course of the ring corridor. It is also unclear whether a part of a plaza may have been recorded in the southeast.

Despite the natural protection of the settlement through its location on a promontory, it was apparently fortified at least twofold. This fortification is manifested in the settlement plan by highly magnetic linear anomalies of about 1–1.5 m width. Analogous to the situation at the still superficially visible fortification in the central area of the settlement, the peripheral located linear fortifications could most likely represent narrow ditches from palisades.

In the southwest, on the inner side of the fortification, there were round anomalies with diameters of 3–4 m and flux densities of 75–100 nT, which can be interpreted as possible remains of pottery kilns, in analogy to findings in the Ukraine and Moldova (*e.g.* Kruts *et al.* 2013; Korvin-Piotrovskiy *et al.* 2016; Țerna *et al.* 2019a; Fig. 18). Similar pottery kilns have also been identified in slightly younger settlements of the phase Trypillia C2 in the micro-region (Sîrbu 2015).

Summary and remarks on Trinca-*La Șanț*

In Trinca-*La Șanț*, a large part of a settlement has been archaeomagnetically investigated; the classical principle of Trypillian settlement organisation with concentric rows of houses and a ring corridor was constructed on a naturally protected limestone plateau. Pottery styles and a ^{14}C dating suggest the occupation of the site between 3900 and 3700 BCE, a period that in the Central Ukrainian Sinyucha

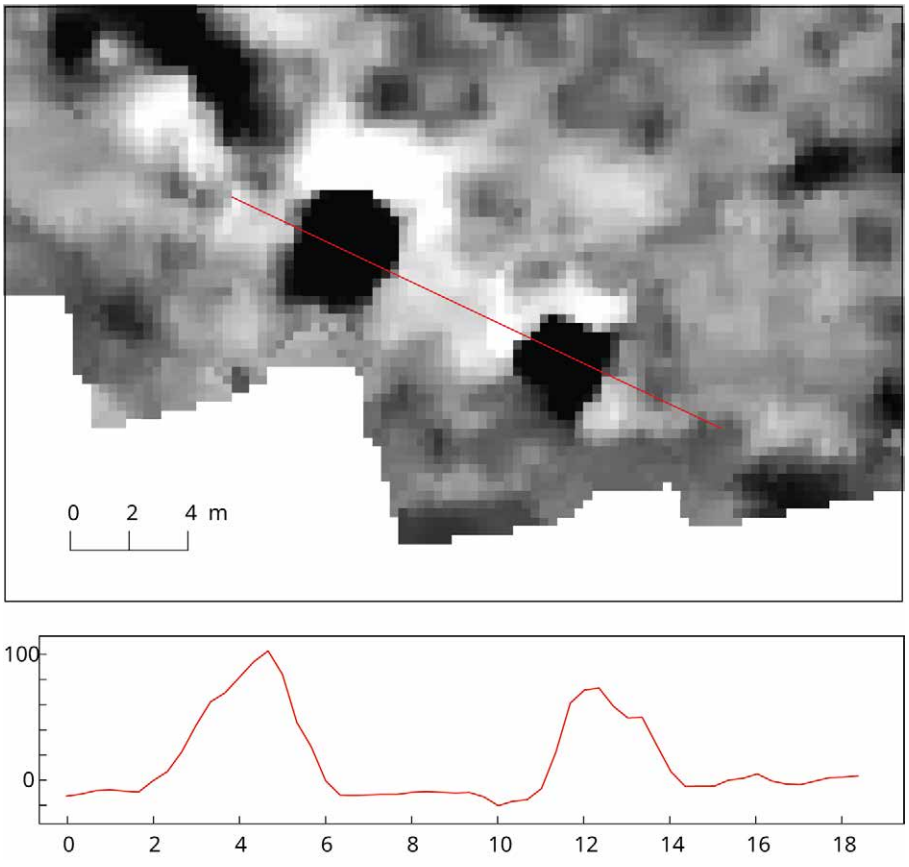


*Figure 18. Trinca-*La Șanț*: Detail of the magnetic map with round anomalies of possible pottery kilns on the southwestern edge of the plateau. Below is a profile of the two anomalies showing the amplitude and dimensions of the anomalies (graphic: R. Hofmann).*

River catchment represented the zenith of Trypillian population aggregation in ring-shaped Trypillia mega and smaller sites in terms of population sizes (Shatilo 2021). In other regions, such as the Dnieper area, large communities were already in a state of decline in the 37th century BCE (Hofmann and Shatilo 2022).

The settlement of Trinca-*La Șanț* differs from earlier settlements such as Petreni and Stolniceni 1, among others, by its exposed and naturally fortified location at the top of a limestone plateau. Perhaps the aspect of safety played an essential role, manifested here by an atypical elongated settlement layout and limited space conditions. Based on this evidence, future work should focus on resolving the question of whether we might have to expect increased conflict in this period.

The settlement area available on the plateau amounted at least 14.6 ha, of which 8.35 ha or about 60% was surveyed. If we take the estimated total number of 200 houses in the surveyed area as a basis and also consider the existence of a plaza without residential buildings, we would have to expect approximately 300 houses, extrapolating to the entire settlement area. If we further assume that only 50% of the houses were used at the same time and that on average 5 persons lived in one house, we would have to assume a maximum of 750 inhabitants in the settlement. It should be noted, however, that the lack of more precise data on the duration of the settlement is likely to affect unfavourably the accuracy of this estimate.

In the light of the new results it seems certain that the rampart-ditch system in the centre of the settlement cannot belong to the Copper Age: this fortification system divides the settlement in the centre, without taking into account its ring-shaped structure. A post-Trypillia dating of this fortification is also supported by the earth masses of the rampart which overlie burnt Trypillia houses.

Discussion

Settlement layout

At both sites (even though Trinca-*La Șanț* has been investigated incompletely), our survey provides a detailed insight into settlement organisation, layout and size; moreover, the comparison of both cases offers a good opportunity to address the general problem of settlement structure at Cucuteni A and B stages and the diachronic changes in the layout of Cucuteni-Trypillia sites from the middle to late stages of this culture's development.

Thus, as has been elsewhere mentioned, a row- and regular or dispersed group-based settlement layout is a general characteristic of the Cucuteni A period (Sorochin 1993; Lazarovici and Lazarovici 2007, 171ff.). Indeed, if we take a look at some of the available settlement plans, both from large-scale excavations and recent geophysics (Fig. 10), they seem to display a mixture of (sometimes slightly irregular) linear pattern with a grouped one. In some cases, larger buildings are located in the centre of house-groups. The possible asynchrony of houses within these spatial patterns should be of course kept in mind; on the other hand, the plans do not display many clearly overlapping features. The Putinești 3 layout corresponds to the general trends of the period and shows a complicated layout with both linear rows and groupings of 3 to 9 dwellings (Fig. 9).

Regarding the circular layout from Trinca-*La Șanț*, this fits well to the pattern widespread at Trypillia B1–B2, B2 and C1 phases, from North-Eastern Romania to the Dnieper basin in Ukraine. A concentric arrangement of houses within a round or oval settlement has been witnessed at dozens of settlements already, and their number increases constantly, thanks to modern geophysics and availability of satellite imagery (Fig. 19). In the Republic of Moldova, there are almost 20 radial

Trypillia B2 and C1 sites recorded at the time of writing. They are generally spread across the northern part of the country and seem to avoid high landforms, although the final picture of radial sites distribution has to be assembled after further intensive field walking has taken place, since many of the northern districts are still insufficiently researched; we therefore assume that the distribution presented here is not complete and might be subject to modifications in the future. The choice of a concentric settlement layout does not seem to be determined by the size of the site since concentric elements have been encountered for settlements ranging from 5 to 45 ha. We can therefore regard the concentric layout of settlements as a cultural tradition manifested on sites of various size and – as the location on a high promontory at Trinca shows us – topographical conditions.

In general terms, despite several exceptions, the size of settlements in the Cucuteni-Trypillia culture gradually increases from the earliest stage (Pre-Cucuteni) to the late Trypillia C1 stage, followed by a radical decrease at the transition to the Trypillia C2 period. With its 5 hectares, Putinești 3 can be considered a large settlement for the Cucuteni A stage (cf. Monah and Cucoș 1985, 43) while the 15 ha (at least) of Trinca-*La Șanț* is of rather a medium size for the Cucuteni B/Trypillia C1 stage, when settlements numbering several dozens or even hundreds of hectares appear. A contemporary reevaluation of size classification of Cucuteni-Trypillia settlements is however a task to be fulfilled by future research.

House size

Let us turn now to house dimensions. Generally, based on information from other settlements, the median value for house area in Cucuteni A period does not exceed 50 m^2 (Appendices 2 and 3) and is smaller than the value recorded for Cucuteni B settlements which is circa 65 m^2 (Appendices 4 and 5). It should be stressed here that this increase in house area has been mainly achieved by the growth of house length and not the width. The median value of house area at Putinești 3 amounts to 89 m^2 (calculated for the 57 secure houses including the excavated ones) and is therefore much higher than the area of houses within other Cucuteni A settlements, while the area of Trinca-*La Șanț* houses is slightly smaller than has been recorded for other Cucuteni B sites, corresponding well to the average area of houses in Petreni (Fig. 20). At present, we cannot find a comprehensive explanation of such a large average size for Putinești houses. It may of course represent a local peculiarity; on the other hand, data from the contemporary settlement of Drăgușeni (with an average floor area of 64 m^2) may suggest that the increase of floor space is a broader phenomenon which is generally characteristic for the end of the Cucuteni A stage (Cucuteni A_4), preceding the appearance of concentric complex settlements at the Cucuteni A–B_1 stage. Verification of both these assumptions should be made after more Cucuteni A settlement plans are developed.

Interpreting the variability of house sizes remains a complex problem that has only been solved to some extent so far. Although the analysis of cross-cultural samples has shown a tendency to correlate the floor space of houses with the number of household inhabitants (*e.g.* Porčić 2011), other factors such as residential mobility patterns (*e.g.* Porčić 2012), descent rules (*e.g.* Porčić 2010) and household wealth (Kohler *et al.* 2017) obviously also play an important role. Increasing house sizes have also been documented in other regions of Central and South-Eastern Europe and interpreted as an expression of emerging households and a general trend towards greater sedentarism (Müller 2013) or increasing household autonomy, in the context of the disintegration of aggregated settlements (Hofmann 2015). In order to better understand the long-term increase in house sizes in communities with Cucuteni-Trypillia ceramics identified in this paper, a broader, regionally differentiated study is required that particularly takes into

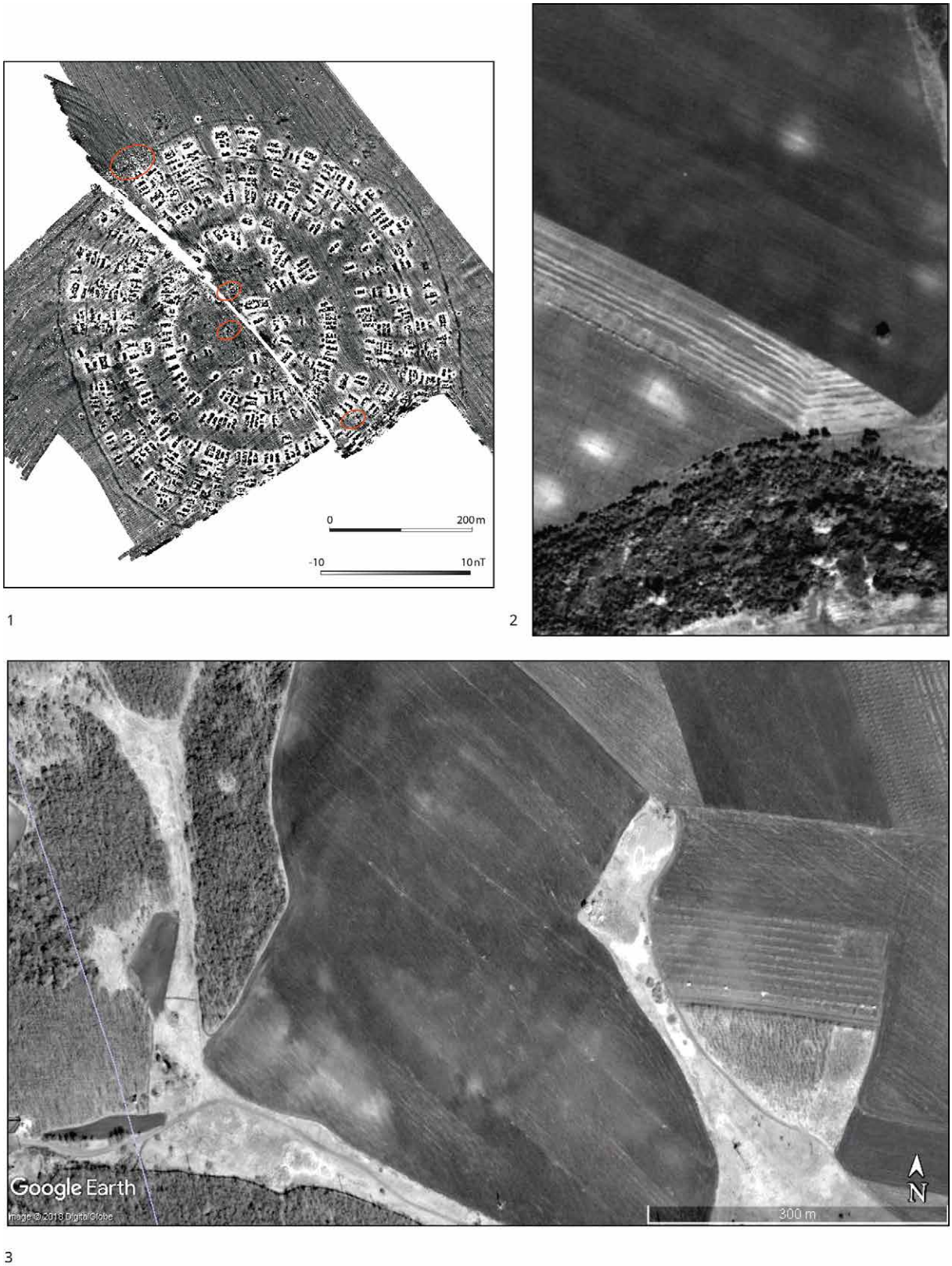


Figure 19. Layout of radial Cucuteni B/Trypillia B2, B2–C1, C1, C1–C2 settlements on the territory of the Republic of Moldova: 1. Petreni (after Rassmann et al. *2016b); 2. Bogdănești (from Google Earth); 3. Bădiceni (from Google Earth; graphic: S. Țerna).*

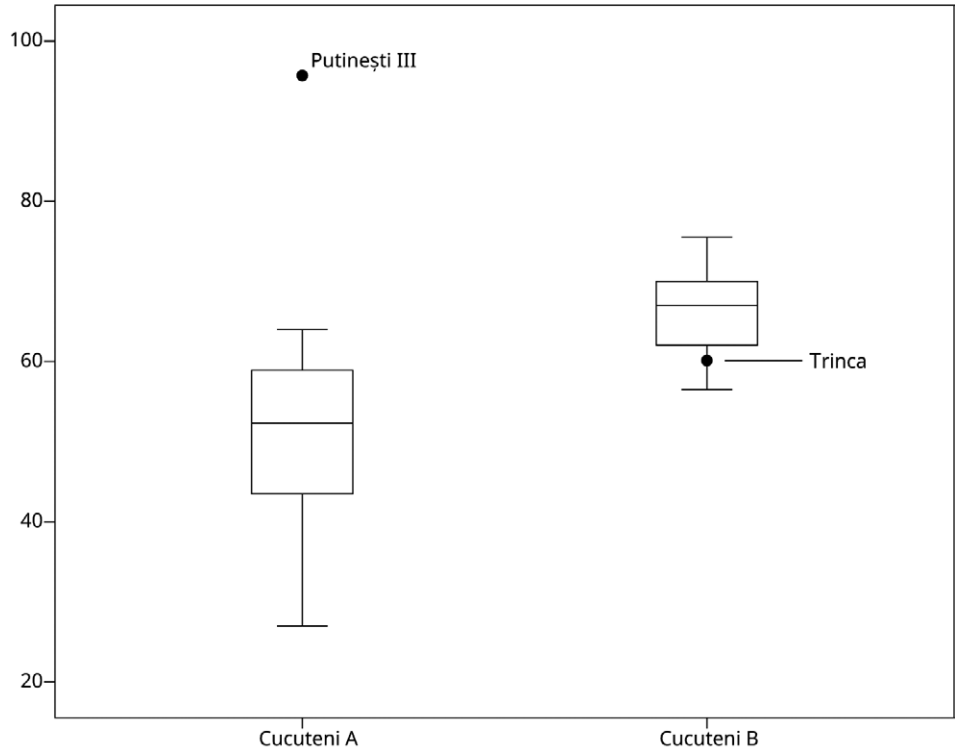


Figure 20. Boxplot diagrams of the house area at Cucuteni A and B stages, based on the data from Appendices 1–5 (graphic: S. Țerna).

account the context of these changes, *e.g.* with regard to economic determinants and processes of population aggregation and dispersion. According to the current state of research, further preparatory work is required for this.

Fortification system

Both sites investigated were built in naturally protected locations and showed additional features with a possible fortificatory character such as ditches and palisades. At Putinești 3, one of the results of the new investigation is the discovery of a previously unknown ditch-palisade system which enclosed the settlement from the Southern unprotected side. The width of the ditch anomaly is ca. 2.5 m while the width of the palisade ditch anomaly is about 0.8 m. The total length of the enclosure amounts ca. 286 m. At Trinca-*La Șanț*, a complex system of ditches has been recorded, one of which is obviously of post-Trypillia age while the others may be connected to the Copper Age settlement. Thus, one ditch with the width of ca. 3 m and length of ca. 300 m enclosed the settlement from the Southern unprotected side of the promontory, while the steep rocky sides from North, West and East were reinforced by narrower ditches which may have served as foundations for fences or a palisade.

Enclosures represent a frequent phenomenon in the Cucuteni-Trypillia archaeology. Starting from earliest settlements like Baia (Hofmann *et al.* 2016), various earthworks have been recorded at sites throughout the entire span of the culture's evolution, up to the latest Trypillia C2 settlements dated back to the second half of the 4th millennium BCE. The quantity of attested enclosed settlements dramatically increased in the last decade as a result of geophysical surveys carried out with modern high-resolution equipment; as the case of Putinești 3 or Ukrainian mega-sites (Maidanetske) show us, enclosures continue to be discovered even on settlements already surveyed in the past.

Within the sequence of Cucuteni-Trypillia settlements, enclosures are not evenly frequent and show partly different characteristics: as already remarked by

researchers, for the Cucuteni A/Trypillia B1 stage, in this period we see the highest frequency of enclosures with defensive potential (Dergachev 2007; Saile *et al.* 2016). Earthworks of these stages are characterised by considerable depth and width and usually enclose one side of the settlements and are located on high promontories with three steep and naturally protected sides, just as at Putinești 3. On some sites, enclosures delineate the complete extent of the settlement or one of its inner phases (Scânteia: Mischka *et al.* 2016; Războieni: Asăndulesei 2017). A trend to situate the sites in naturally protected locations is a general characteristic of this period (Manzura 2005, 318). When corroborated with other evidence from material culture such as a high frequency of display of various prestige items or large number of weapons including flint arrowheads (sometimes found along the walls of houses as at Druța: Ryndina and Engovatova 1990) this reflects a stress or critical situation driven most probably by internal causes (Manzura 2005) and not by external threats originating from the steppes (cf. Dergachev 2007).

In contrast, the Cucuteni B/Trypillia B2 and C1 earthworks are much more variable and their defensive potential is not so obvious in many of the investigated settlements. When comparing for instance some of the excavated Cucuteni A ditches to the ones researched at large ring-shaped sites in Moldova and Ukraine, we observe a clear differentiation in terms of depth. Cucuteni B ditches are generally narrower, their depth is smaller (Appendix 6; Fig. 21) and the settlements are located on open terrain which is not naturally protected, even if sometimes the enclosing earthworks are impressive and consist of three ditches and a palisade, as is the case of Stolniceni, Moldova (Țerna *et al.* 2016; Țerna *et al.* 2019b). In these settlements, the function of the ditches might have been rather an orientational, symbolic or delineating one (cf. Bem 2001). Recently, this trend has been confirmed by investigations in the mega-sites of Nebelivka and Maidanetske, where consistently ditches of very small dimensions have been proven to be segments of causewayed enclosures (Ohlrau 2020, 106–117; Videiko and Chapman 2020). This shows that considerable work is still needed to achieve a coherent functional, regional and temporal classification and differentiation of enclosures and other potentially fortificatory features of Trypillia sites (cf. Rud *et al.* 2021).

While in Putinești 3 a defensive character of the ditch-palisade system seems unquestionable in the context of contemporaneous evidence, this is not so obvious in the case of the Trinca-*La Șanț* settlement, although the unusual location of the latter settlement on a naturally protected rocky plateau and the existence of a ditch and palisade system may indicate this. However, the contemporaneous evidence from the wider catchment area of Cucuteni-Trypillia settlements is considerably more ambivalent and enables other interpretations to be proposed.

Conclusion

This paper presents new geophysical data from two Copper Age settlements in different parts of the Republic Moldova, which contribute to the discussion of various issues concerning the development of communities with Cucuteni-Trypillia pottery of the 5th and 4th millennia BCE. Both settlements were established in naturally protected locations, but represent different stages in the development of settlement plans. As similar constructions show, for example in Trușești-Țuguieta (Petrescu-Dîmbovița *et al.* 1999), Ghelaiesti-*Dealul Nedeea* (Mischka *et al.* 2019) and Războieni, Dealul Mare/ Dealul Boghiu (Asăndulesei 2017), the settlement Putinești 3 from the second half of the 5th millennium fits smoothly into the context of other settlements of this period, characterised by a central plaza, radial and concentric rows of houses as well as by location on promontories. In contrast, the settlement Trinca-*La Șanț*, which most likely dates to the 38th century BCE, represents a special case insofar as a ring-shaped

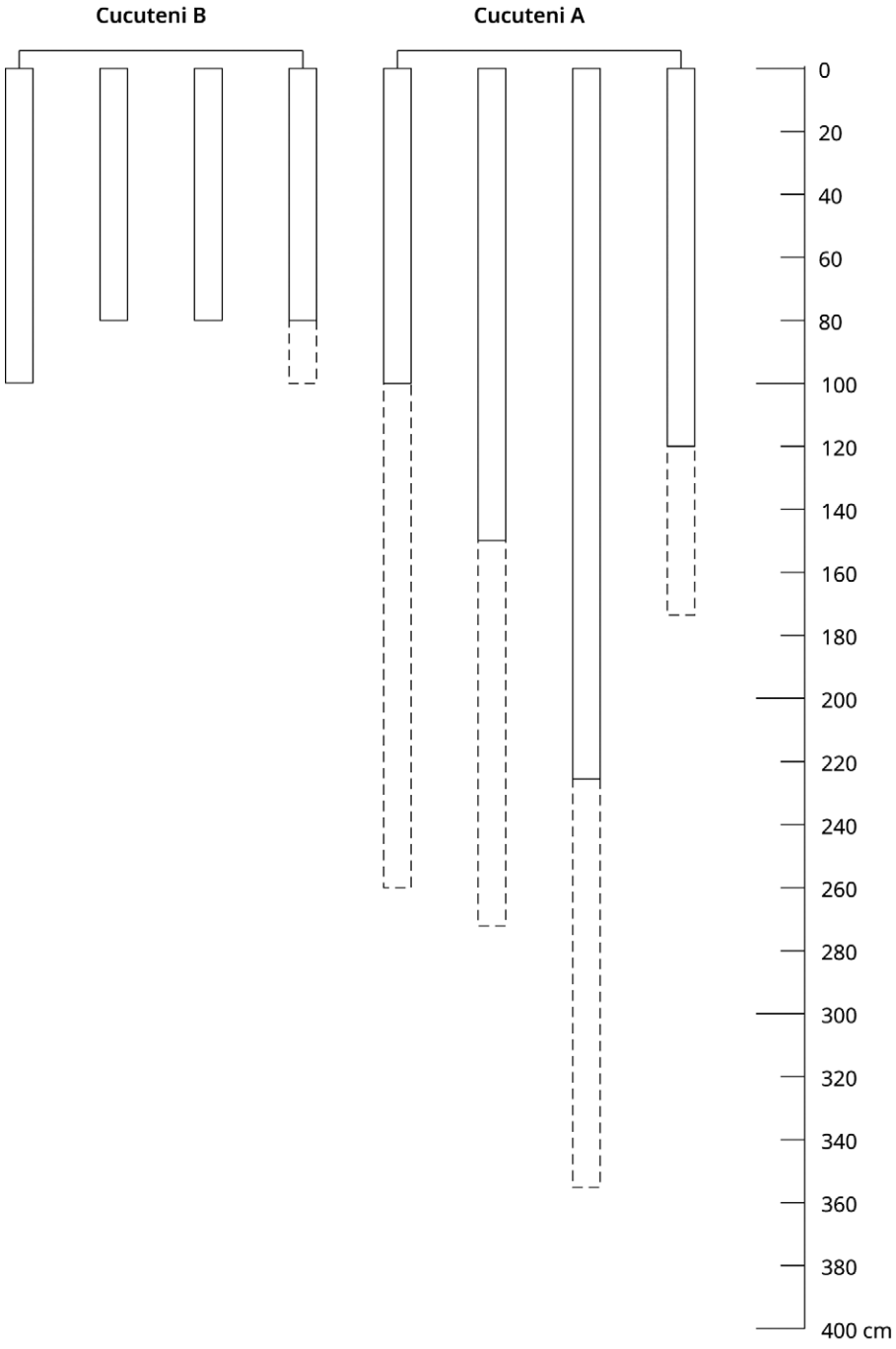


Figure 21. Comparison of depth of Cucuteni A and B ditches, based on the data from Appendix 6 (graphic: S. Terna).

settlement layout was developed under very restricted spatial conditions, on top of a prominent rock plateau, which would normally have been established in open terrain. Alongside the fundamental transition from row-based to concentric layouts with a ring-corridor, there are indications of a development towards larger houses, the reasons for which, however, are not yet clearly apparent from the current state of research; this therefore requires a broader investigation. Although both settlements seem to have a defensive character, a contextual comparison with contemporaneous settlements shows fundamental differences regarding the possible function of 'fortificatory' facilities. For a more precise understanding of these differences, however, a regionally differentiated study is required that takes into account further contextual information, *e.g.* the intensity of population agglomeration and dispersal.

Acknowledgements

The field research was financed by postdoctoral funds from the Kiel Graduate School 'Human Development in Landscapes' (German Research Foundation project number 390717). The completion of this paper was funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) – Project-ID 290391021 – Sonderforschungsbereich 1266. Besides the authors, Lennard Brandtstätter, Wiebke Mainusch, Marcel Rodens and Gesa-Kristin Salefsky participated in the fieldwork and we would like to thank them for their dedicated work.

Appendices

*Appendix 1. List of house areas in the settlements Putinești 3 and Trinca-*La Șanț *(in m²) according to the magnetic plans.*

Putinești 3

120, 78.8, 64.1, 68, 84.6, 94.1, 88.7, 77.5, 68.4, 105.3, 101.4, 108.9, 64.3, 83.7, 136, 100, 109.2, 98.8, 67.3, 141.9, 55.2, 71.6, 51.8, 86.4, 113.4, 134.4, 151.3, 100.6, 158.8, 137.7, 104, 184.3, 171.9, 59.1, 69.7, 97.1, 88.5, 133.5, 134.7, 64.4, 130.7, 140, 74.5, 77.5, 97.7, 93.3, 84, 94.6, 122.5, 66.7, 87.1, 76.1, 72.9, 90.5, 77.4, 115.1, 96.7, 158, 75.2, 142.8, 117.2, 129.8, 77.4, 129.4, 74.6, 119.8, 69.2, 57.2, 48.1, 88.7, 87.2, 56.9, 71.7

Trinca-*La Șanț*

130.7, 15.5, 155.8, 18, 29.1, 33.6, 34.5, 35, 36.2, 36.7, 36.9, 37.2, 37.6, 39.1, 39.6, 39.6, 41.1, 41.5, 42.2, 42.5, 42.6, 43.1, 44.3, 44.5, 45.7, 46, 46.1, 46.2, 47.2, 47.5, 48.1, 48.1, 49.3, 50.6, 52.2, 52.7, 53, 55.3, 56.9, 57.1, 57.8, 58.2, 58.3, 58.5, 59.2, 60.2, 60.8, 60.8, 64.5, 65, 65.8, 66.1, 66.4, 66.5, 67.1, 67.7, 67.9, 68.3, 69.3, 69.6, 69.9, 70.3, 71.6, 73.1, 73.4, 73.6, 76, 76.9, 77.9, 78.2, 78.8, 81.4, 84.4, 84.7, 87.4, 87.6, 90.2, 90.6, 99.3

Appendix 2. Area of Cucuteni A/ Trypillia B1 houses excavated in Moldova.

Site / dwelling №	Dating	Area (m2)	References
Cuconeștii Vechi 1	Cucuteni A3		Marchevici 1997; Chitic 2008
Dwelling 1		48	
Dwelling 2		92	
Dwelling 4		40.8	
Druța 1	Cucuteni A4		Sorochin 2002; Chitic 2008
Dwelling 1		49.2	
Dwelling 2		113.4	
Dwelling 3		40	
Duruitoarea Nouă 1	Cucuteni A4		Sorochin 2002; Chitic 2008
Dwelling 1		40	
Dwelling 2		87.5	
Duruitoarea Veche 1	Cucuteni A4		Sorochin 2002; Chitic 2008
Dwelling 1		110.5	
Jora de Sus	Cucuteni A2		Sorochin 1982
Dwelling 1		36	
Dwelling 2		48.84	
Putinești 3	Cucuteni A4		Sorochin 2002
Dwelling 1		97.68	
Dwelling 2		132.61	
Dwelling 5		72	
Dwelling 6		24	
Dwelling 7		64.4	
Ruseștii Noi 1	Cucuteni A2		
Dwelling 1		20	Markevich 1970
TOTAL		**52.3 (average), 40.8 (median)**	

Appendix 3. Average house area for Cucuteni A/Trypillia B1 settlements from prospected and large-scale excavated sites in Romania and Moldova.

Site	Dating	Size (survey or excavation / total), ha	Number of houses	Average house area (m2)	References
Adâncata A	Cucuteni A4/A–B1	1.85/1.85	>2	27	Hofmann *et al.* 2016
Adâncata B	Cucuteni A4/A–B1	1/1	22	48	Hofmann *et al.* 2016
Cobani	Cucuteni A	1.5/4.5	24	39	Rassmann *et al.* 2016b
Drăgușeni-Ostrov	Cucuteni A4	0.32/9	19	64 (median = 50)	Marinescu-Bîlcu and Bolomey 2000
Putinești 3	Cucuteni A4	4/4	57 (secure) + 22 (probable) = 79	95.7 (median = 89), calculated for secure houses only	This chapter
Hăbășești	Cucuteni A2–A3	1.5/1.5	45	53.8 (median = 49.75)[1]	Dumitrescu *et al.* 1954
Trușești	Cucuteni A3	3/3	93	45.5	Petrescu-Dîmbovița *et al.* 1999

Appendix 4. Area of Cucuteni B/ Trypillia B2, B2–C1, C1 and C1–C2 houses excavated in Moldova.

Site / dwelling №	Dating	Area (m2)	References
Bădragii Vechi	*Trypillia C1/C2*		Markevich 1981b
Dwelling 1		60	
Dwelling 2		160	
Brînzeni IV	*Trypillia B2/C1*		Markevich 1981b
Dwelling 1		70	
Brînzeni VIII	*Trypillia B2*		Markevich 1981a
Dwelling 1 (5)		92.25	
Dwelling 2 (6)		51.5	
Dwelling 3 (7)		60	
Glavan I			Bikbaev 1992
Dwelling 1		72	
Dwelling 2		13.5	
Dwelling 3		32.4	
Racovăț	*Trypillia B2*		Chernysh 1973
Dwelling 1		59.5	
Dwelling 1a		35	
Dwelling 3		49	
Dwelling 3a		37.12	
Șuri *I*	*Trypillia C1/C2*		Bikbaev 1989
Dwelling 1		53.36	
Vărvăreuca VIII	*Trypillia C1*		Markevich 1981b
Dwelling 1		60	
Dwelling 2		70	
Dwelling 3		81	
Dwelling 4		65.8	
Dwelling 5		58.3	
Dwelling 6		127.2	
Vărvăreuca XV	*Trypillia C1*		Markevich 1981b
Dwelling 1		175	Markevich 1981b
TOTAL		**75.46 (average), 65 (median)**	

1 Data available for 30 out of 45 dwellings.

Appendix 5. Average house area for prospected Cucuteni B/Trypillia B2–C1 and C1 settlements from Moldova and Ukraine.

Site	Dating	Size (prospection / total), ha	Number of houses	Average house area (m2)	References
Dobrovody	Trypillia C1	19/170	213	64	Rassmann *et al.* 2016a
Maidanetske	Trypillia C1	165/200	1872	67	Rassmann *et al.* 2016a
Petreni	Trypillia B2/C1	22/26	449	56.5	Rassmann *et al.* 2016b
Stolniceni	Trypillia B2/C1	14/33	140	68	Țerna *et al.* 2016
Talianki	Trypillia C1	195/320	1368	72	Rassmann *et al.* 2016a
Trinca-*La Șanț*	Trypillia C1	8/15	82 (secure) + 51 (probable) = 133	60.1 (median = 58.8), calculated just for secure houses	This chapter

Appendix 6. Dimensions of ditches excavated on Cucuteni A/Trypillia B1 and Cucuteni B/ Trypillia B2/C1 and Trypillia C1 settlements.

Site	Stage	Depth (m)	Literature
Stolniceni inner ditch	Cucuteni B/Trypillia B2–C1	1 (from prehistoric step-surface)	This chapter
Stolniceni middle ditch	Cucuteni B/Trypillia B2–C1	0.8 (from prehistoric step-surface)	This chapter
Nebelivka	Cucuteni B/Trypillia B2	0.8	Videiko et *al.* 2015
Petreni outer ditch	Cucuteni B/Trypillia B2–C1	0.8–1	Uhl *et al.* 2017
Trușești	Cucuteni A/Trypillia B1	1–2.6	Petrescu-Dîmbovița *et al.* 1999
Hăbășești inner ditch	Cucuteni A/Trypillia B1	1.5–2.75	Dumitrescu *et al.* 1954
Hăbășești outer ditch	Cucuteni A/Trypillia B1	2.25–3.55	Dumitrescu *et al.* 1954
Târpești	Cucuteni A/Trypillia B1	1.2–1.75	Marinescu-Bîlcu 1981

References

Asăndulesei, A., 2017. Inside a Cucuteni Settlement: Remote Sensing Techniques for Documenting an Unexplored Eneolithic Site from Northeastern Romania. *Remote Sensing*, 9 (1), 41. Available from: DOI:10.3390/rs9010041

Asăndulesei, A., Tencariu, F.A. and Nicu, I.C., 2020. *Pars pro toto*—Remote Sensing Data for the Reconstruction of a Rounded Chalcolithic Site from NE Romania: The Case of Ripiceni-*Holm* Settlement (Cucuteni Culture). *Remote Sensing*, 12 (5), 887. Available from: DOI:10.3390/rs12050887

Bem, C., 2001. Les fortifications de l'aire Precucuteni et Cucuteni. Entre les axioms et arhétypes. *Cultură* și *Civilizație la Dunărea de Jos*, XVI-XVII, 53–98.

Bikbaev 1989: Бикбаев, В.М., 1989. Исследования трипольского поселения Шуры I. Археологические исследования в Молдавии, 1984, 50–60.

Bikbaev 1992: Бикбаев, В.М., 1992. Исследования поселения культуры Кукутень-Триполье Главан I. *In*: В.И. Гросу, В.С. Селенчук, С.С. Курогло, И.В. Манзура and В.Я. Сорокин, eds. Материалы и исследования по археологии и этнографии Молдовы. Кишинев: Штиинца, 101–117.

Bojadžiev, J., 1998. Radiocarbon dating from southeastern Europe. *In*: M. Stefanovich, H. Todorova and H. Hauptmann, eds. *In the Steps of James Harvey Gaul*, Vol. 1: *James Harvey Gaul in Memoriam*. Sofia: The James Harvey Gaul Foundation, 349–370.

Chapman, J., Videiko, M.Y., Hale, D., Gaydarska, B., Burdo, N., Rassmann, K., Mischka, C., Müller, J., Korvin-Piotrovskiy, A.G. and Kruts, V., 2014. The Second Phase of the Trypillia Mega-Site Methodological Revolution: A New Research Agenda. *European Journal of Archaeology*, 17 (3), 369–406. Available from: DOI:10.1179/1461957114Y.0000000062

Chernovol, D., 2012. Houses of the Tomashovskaya Local Group. *In:* F. Menotti and A.G. Korvin-Piotrovskiy, eds. *The Tripolye Culture Giant-Settlements in Ukraine. Formation, Development and Decline*. Oxford, Oakville: Oxbow Books, 182–209. Available from: DOI:10.2307/j.ctvh1dvmn.13

Chernysh 1973: Черныш, Е.К., 1973. Трипольское поселение Раковец. Краткие Сообщения Академия Наук СССР, 134, 48–57.

Chitic, O., 2008. Elements d'habitat de la période Cucuteni A et Cucuteni A-B de l'espace Pruto-Dniestreen. *In*: V. Chirica and M.-C. Văleanu, eds. *Etablissements et habitations préhistoriques. Structure, organisation, symbole*. Bibliotheca Archeologica Moldaviae IX. Iași: PIM, 263–314.

Dergachev 2007: Дергачев, В.А., 2007. О скипетрах, о лошадях, о войне. Этюды в защиту миграционной концепции М. Гимбутас. Санкт-Петербург: Нестор.

Dudkin 1978: Дудкин, В.П., 1978. Геофизическая разведка крупных трипольских поселений. *In*: В.Ф. Генинг, ed. Использование методов естественных наук в археологии. Киев: Издательство «Наукова думка», 35–45.

Dudkin and Videiko 2009: Дудкін, В. and Відейко, М., 2009. Архітектура Трипільської цивілізації від поселень до протоміст. Київ: Мислене древо.

Dumitrescu, V., Dumitrescu, H., Petrescu-Dîmboviţa, M. and Gostar, N., 1954. *Hăbășești. Monografie arheologică*. București: Editura Academiei Republicii Populare Române.

Harper, T.K., 2013. The effect of climatic variability on population dynamics of the Cucuteni-Tripolye cultural complex and the rise of the Western Tripolye giant-settlements. *Chronika*, 3, 28–46. Available from: https://www.chronikajournal.com/resources/Harper%202013.pdf

Hofmann, R., 2015. The Bosnian Evidence: The New Late Neolithic and Early Copper-Age Chronology and Changing Settlement Patterns. *In*: S. Hansen, P. Raczky, A. Anders and A. Reingruber, eds. *Neolithic and Copper Age between the Carpathians and the Aegean Sea. Chronologies and Technologies from the 6th to*

the 4th Millenium BCE. International Workshop Budapest 2012. Archäologie in Eurasien 31. Bonn: Dr. Rudolf Habelt, 219–241.

Hofmann, R. and Müller-Scheeßel, N., 2020. Orientation of Neolithic dwellings in Central and Southeast Europe: Common denominator between the Vinča and Linearbandkeramik worlds. *Quaternary International*, 560–561, 142–153. Available from: DOI:10.1016/j.quaint.2020.05.006

Hofmann, R. and Shatilo, L., 2022. Tripolye population aggregation and dispersal in light of regional settlement trajectories. *In*: M. Dębiec, J. Gorski, J. Müller, M. Nowak, A. Pelisiak, T. Saile and P. Włodarczak, eds. *From Farmers to Heroes? Archaeological Studies in Honor of Sławomir Kadrow*. Universitätsforschungen zur prähistorischen Archäologie 376. Bonn: Dr. Rudolf Habelt, 197–212.

Hofmann, R., Țerna, S., Ursu, C.-E., Brandtstätter, L., Tiede, H., Mainusch, W. and Authenrieth, S., 2016. Spatial organization and population size of small Cucuteni-Tripolye settlements: Results of geomagnetic surveys in Baia and Adâncata, Suceava County, Bucovina, Eastern Romania. *Journal of Neolithic Archaeology*, 18, 157–189. Available from: DOI:10.12766/jna.2016.4

Hofmann, R., Medović, A., Furholt, M., Medović, I., Stanković-Pešterac, T., Dreibrodt, S., Martini, S. and Hofmann, A., 2019. Late Neolithic multicomponent sites of the Tisza region and the emergence of centripetal settlement layouts. *Praehistorische Zeitschrift*, 94 (2), 351–378. Available from: DOI:10.1515/pz-2019-0003

Kohler, T.A., Smith, M.E., Bogaard, A., Feinman, G.M., Peterson, C.E., Alleen, B., Pailes, M., Stone, E.C., Marie Prentiss, A.M., Dennehy, T.J., Ellyson, L.J., Nicholas, L.M., Faulseit, R.K., Styring, A.K., Whitlam, J., Fochesato, M., Foor, T.A. and Bowles, S., 2017. Greater post-Neolithic wealth disparities in Eurasia than in North America and Mesoamerica. *Nature*, 551, 619–622. [Corrigendum in: *Nature*, 555 (2018), 126]. Available from: DOI:10.1038/nature24646

Korvin-Piotrovskiy, A., Hofmann, R., Rassmann, K., Videiko, M.Y. and Brandtstätter, L., 2016. Pottery Kilns in Trypillian Settlements. Tracing the Division of Labour and the Social Organization of Copper Age Communities. *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE.* Themes in Contemporary Archaeology 2. London, New York: Routledge, 221–252. Available from: DOI:10.4324/9781315630731

Kruts, V., Korvin-Piotrovskiy, A.G., Mischka, C., Ohlrau, R., Windler, A. and Rassmann, K., 2013. The Geomagnetic Prospection. *In*: A.G. Korvin-Piotrovskiy and K. Rassmann, eds. *Talianki – Settlement-Giant of the Tripolian Culture. Investigations in 2012*. Kiev: Institute of Archaeology of the National Academy of Sciences of Ukraine, 85–103.

Lazarovici, C.-M., 2010. New data regarding the chronology of the Precucuteni, Cucuteni and Horodiştea-Erbiceni cultures. *In*: J. Šuteková, P. Pavúk, P. Kalábková and B. Kovár, eds. Panta Rhei: Studies on the Chronology and Cultural Development of South-Eastern and Central Europe in Earlier Prehistory Presented to Juraj Pavúk on the Occasion of his 75th Birthday. Studia Archaeologica et Medievalia XI. Bratislava, Olomouc: Comenius University, 91–114.

Lazarovici, C.-M. and Lazarovici, G., 2007. *Arhitectura neoliticului* și *epocii cuprului din România*, Vol. 2: *Epoca Cuprului*. Iași: Trinitas.

Levițki, O. and Alaiba, R., 2008. Ceramica pictată din etapa Cucuteni B2, descoperită la Trinca – La Șanț, raionul Edineț, Republica Moldova. *Carpica*, XXXVII, 176–193.

Levițki, O. and Alaiba, R., 2009. The archaeological site Trinca-La Șanț, Cucuteni B2, Edineț District, Republic of Moldova. *Annales d'Université Valahia Târgoviște, Section d'Archéologie et d'Histoire*, XI (2), 23–39.

Levițki, O. and Alaiba, R., 2010. Anthropomorphic statuettes discovered in the settlement of Trinca – La Șanț. *Carpica*, XXXVIII, 18–28.

Levițki, O. and Chitic, O., 2006. În ce perioadă putea fi fortificată așezarea Trinca – La Șanț (raionul Edineț, Republica Moldova)? *Revista Arheologică*, II (1–2), 169–180.

Leviţki, O., Alaiba, R. and Bubulici, V., 1999. Raport asupra investigaţiilor arheologice efectuate în anii 1997-1998 la Trinca „Izvorul lui Luca", raionul Edineţ, Republica Moldova. *Cercetări Arheologice* în *Aria Nord-tracă*, III, 17–166.

Leviţki, O., Sîrbu, G., Sîrbu, L. and Heghea, S., 2013. Cercetările arheologice din situl Trinca – La Șanţ, campania anului 2011. Rezultate preliminare. *Revista Arheologică SN*, IX/2, 136–160.

Leviţki, O., Sîrbu, G. and Bajureanu, I., 2016. Microzona Trinca în contextul eneoliticului est-carpatic. *In*: S. Ţerna and B. Govedarica, eds. *Interactions, changes and meanings. Essays in honour of Igor Manzura on the occasion of his 60th birthday* / Культурные взаимодействия. Динамика и смыслы. Сборник статей в честь 60-летия И. В. Манзуры. Kishinev: University of High Anthropological School, 255–271.

Manzura, I., 2005. Steps to the steppe: Or, how the North Pontic region was colonised. *Oxford Journal of Archaeology*, 24 (4), 313–338. Available from: DOI: 10.1111/j.1468-0092.2005.00239.x

Marchevici, V., 1997. Aşezarea cucuteniană Stânca lui Harascu. *Tyragetia*, IV–V, 81–94.

Marinescu-Bîlcu, S., 1981. *Tîrpești. From Prehistory to History in Eastern Romania*. BAR International Series 107. Oxford: BAR Publishing.

Marinescu-Bîlcu, S. and Bolomey, A., 2000. *Drăgușeni. A Cucutenian Community*. București: Editura Enciclopedică.

Markevich 1970: Маркевич, В.И., 1970. Многослойное поселение Новые Русешты I. Краткие Сообщения Академия Наук СССР, 123, 56–68.

Markevich 1973: Маркевич, В.И., 1973. Памятники эпох неолита и энеолита. Археологическая карта Молдавской ССР 2. Кишинев: Штиинца.

Markevich 1981a: Маркевич, В.И., 1981a. Отчёт о полевых исследованиях 1980 года, проведённых Молдавской археолого-этнографической экспедицией сектора народной культуры с МАЭ. Кишинев. [Archive of the National Museum of History of Moldova, report 158].

Markevich 1981b: Маркевич, В.И., 1981b. Позднетрипольские племена Северной Молдавии. Кишинев: Штиинца.

Mischka, C., 2009. Neue Ergebnisse der geomagnetischen Prospektionen neolithischer und kupferzeitlicher Siedlungen in Rumänien. *Eurasia Antiqua*, 15, 1–14.

Mischka, C., 2012. Late Neolithic Multiphased Settlements in Southern Transilvania: A Geophysical Survey and Test Excavation *In*: R. Hofmann, F.-K. Moetz and J. Müller, eds. *Tells: Social and Environmental Space. Proceedings of the International Workshop "Socio-Environmental Dynamics over the Last 12,000 Years: The Creation of Landscapes II (14th–18th March 2011)" in Kiel*, Vol. 3. Universitätsforschungen zur prähistorischen Archäologie 207. Bonn: Dr. Rudolf Habelt, 153–166.

Mischka, C., Mischka, D. and Rubel, A., 2016. Geomagnetic Survey of Cucuteni-Settlements in Moldova – Results of the FAU Campaign 2015. *Arheologia Moldovei*, 39, 333–345.

Mischka, C., Preoteasa, C. and Schafferer, G., 2019. Gradiometerprospektionen auf Fundplätzen der Cucuteni-Kultur im Kreis Neamţ (Rumänien). Ergebnisse der Jahre 2015 und 2016. *Eurasia Antiqua*, 22 (2016), 115–131.

Monah, D. and Cucoș, Ș., 1985. *Așezările culturii Cucuteni din România*. Iași: Junimea.

Müller, J., 2013. Mesolithisch – neolithisch: Zur Entwicklung von Hütten und Häusern im südlichen Skandinavien und nördlichen Mitteleuropa. *Offa*, 69/70 (2012/2013), 249–264.

Müller, J., Rassmann, K. and Hofmann, R., eds., 2013. *Okolište 1 – Untersuchungen einer spätneolithischen Siedlungskammer in Zentralbosnien*. Universitätsforschungen zur prähistorischen Archäologie 228 (Neolithikum und Chalkolithikum in Zentralbosnien 1). Bonn: Dr. Rudolf Habelt.

Müller, J., Rassmann, K. and Videiko, M., eds., 2016. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE.* Themes in Contemporary Archaeology 2. London, New York: Routledge. Available from: DOI:10.4324/9781315630731

Müller, J., Hofmann, R., Kirleis, W., Dreibrodt, S., Ohlrau, R., Brandtstätter, L., Dal Corso, M., Out, W., Rassmann, K., Burdo, N. and Videiko, M., eds., 2017. *Maidanetske 2013. New excavations at a Trypillia mega-site* / Майданецьке *2013.* Нові розкопки великого Трипільського поселення. Studien zur Archäologie in Ostmitteleuropa 16. Bonn: Dr. Rudolf Habelt.

Müller-Scheeßel, N., Müller, J., Cheben, I., Mainusch, W., Rassmann, K., Rabbel, W., Corradini, E. and Furholt, M., 2020. A new approach to the temporal significance of house orientations in European Early Neolithic settlements. *PLoS ONE*, 15 (1), e0226082. Available from: DOI:10.1371/journal.pone.0226082

Ohlrau, R., 2020. *Maidanets'ke: Development and decline of a Trypillia mega-site in Central Ukraine*. Scales of Transformation in Prehistoric and Archaic Societies 7. Leiden: Sidestone Press. Available from: DOI:10.59641/h0912kt

Ohlrau, R. and Rud, V., 2019. Testing Trypillian site development via geomagnetic survey – New "mega-structures" and plans of smaller sites. *In*: D. Mischka, C. Mischka and C. Preoteasa, eds. *Beyond Excavation. Geophysics, Aerial Photography and the Use of Drones in Eastern and Southeastern European Archaeology. Proceedings of the International Colloquium, 5-8 December 2016, Piatra-Neamț, Romania*. Bibliotheca Memoriae Antiquitatis 40; Erlanger Studien zur Prähistorischen Archäologie 3. Piatra-Neamț: Editura "Constantin Matasă", 87–113.

Petrescu-Dîmboviţa, M., Florescu, M. and Florescu, A.C., 1999. *Truşeşti. Monografie arheologică*. Bucureşti, Iaşi: Editura Academiei.

Pickartz, N., Hofmann, R., Dreibrodt, S., Rassmann, K., Shatilo, L., Ohlrau, R., Wilken, D. and Rabbel, W., 2019. Deciphering archeological contexts from the magnetic map: Determination of daub distribution and mass of Chalcolithic house remains. *The Holocene*, 29 (10), 1637–1652. Available from: DOI:10.1177/0959683619857238

Porčić, M., 2010. House Floor Area as a Correlate of Marital Residence Pattern: A Logistic Regression Approach. *Cross-Cultural Research*, 44 (4), 405–424. Available from: DOI:10.1177/1069397110378839

Porčić, M., 2011. An exercise in archaeological demography: estimating the population size of Late Neolithic settlements in the Central Balkans. *Documenta Praehistorica*, 38, 323–332. Available from: DOI:10.4312/dp.38.25

Porčić, M., 2012. Effects of Residential Mobility on the Ratio of Average House Floor Area to Average Household Size: Implications for Demographic Reconstructions in Archaeology. *Cross-Cultural Research*, 46 (1), 72–86. Available from: DOI:10.1177/1069397111423889

Rassmann, K., Ohlrau, R., Hofmann, R., Mischka, C., Burdo, N., Videjko, M.Y. and Müller, J., 2014. High precision Tripolye settlement plans, demographic estimations and settlement organization. *Journal of Neolithic Archaeology*, 16, 96–134. Available from: DOI:10.12766/jna.2014.3

Rassmann, K., Korvin-Piotrovskiy, A., Videiko, M. and Müller, J., 2016a. The new Challenge for Site Plans and Geophysics: Revealing the Settlement Structure of Giant Settlements by Means of Geomagnetic Survey. *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE*. Themes in Contemporary Archaeology 2. London, New York: Routledge, 29–54. Available from: DOI:10.4324/9781315630731

Rassmann, K., Mertl, P., Voss, H.-U., Bicbaev, V., Popa, A. and Musteaţă, S., 2016b. Copper Age Settlements in Moldova: Insights into a Complex Phenomenon from Recent Geomagnetic Surveys. *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE.* Themes in Contemporary Archaeology 2. London, New York: Routledge, 55–70. Available from: DOI:10.4324/9781315630731

Rud *et al.* 2018: Рудь, В., Улрау, Р., Федоров, С. and Зайцева, О., 2018. Дослідження на поселеннях Трипільської культури Тростянчик та Вийтівка. Археологічні дослідження в Україні, 2016, 11–14.

Rud *et al.* 2021: Рудь, В., Хофманн, Р. and Косаківський, В., 2021. Магнітні аномалії лінійного характеру на поселеннях Трипілля ВІІ Тростянчик та Ворошилівка. *In*: A. Diachenko, T.K. Harper, Y. Rassamakin and I. Sobkowiak-Tabaka, eds. *Data Systematization in the Neo-Eneolithic of Southeastern and Central Europe. Essays in honor of Sergej Ryzhov* / Систематизація неолітичних і енеолітичних матеріалів Південно-Східної та Центральної Європи. Збірка наукових праць на пошану Сергія Рижова. Kyiv: Institute of Archaeology of the National Academy of Sciences of Ukraine, 246–264.

Ryndina and Engovatova 1990: Рындина, Н.В. and Энговатова, А.В., 1990. Опыт планиграфического анализа кремневых орудий трипольского поселения Друцы I. *In*: В.Г. Збенович *et al.*, eds. Раннеземледельческие поселения-гиганты трипольской культуры на Украине. Тез. докл. 1-го полевого семинара. Тальянки, Веселый Кут, Майданецкое: Институт археологии НАН Украины, 108–114.

Saile, T., Posselt, M., Dębiec, M., Kiosak, D. and Tkachuk, T., 2016. Zwei Magnetometerprospektionen auf ukrainischen Fundstellen des Cucuteni-Tripolje-Komplexes an Dnjestr und Südlichem Bug. *Archäologisches Korrespondenzblatt*, 46 (4), 465–477. Available from: DOI:10.11588/ak.2016.4.89983

Shatilo, L., 2021. *Tripolye Typo-chronology: Mega and Smaller Sites in the Sinyukha River Basin.* Scales of Transformation in Prehistoric and Archaic Societies 12. Leiden: Sidestone Press. Available from: DOI:10.59641/m5457py

Sîrbu, G.V., 2015. Гончарные комплексы позднего энеолита Пруто-Днестровского междуречья (по материалам поселения Тринка-Изворул луй Лука) / Late Eneolithic Pottery Kilns of the Prut-Dniester Interfluve (on the basis of materials from the Trinca-Izvorul lui Luca settlement). *Stratum Plus*, 2015 (2), 171–180.

Sorochin 1982: Сорокин, В.Я., 1982. Отчет о полевых исследованиях Оргеевской археологической экспедиции 1981 г. Кишинев. [Archive of the National Museum of History of Moldova, report 170].

Sorochin 1990: Сорокин, В.Я., 1990. Отчет о полевых исследованиях Трипольской экспедиции в 1989 г. Кишинев. [Archive of the National Museum of History of Moldova, report 303].

Sorochin 1991: Сорокин, В.Я., 1991. Отчет о полевых исследованиях Трипольской экспедиции в 1990 г. Кишинев. [Archive of the National Museum of History of Moldova, report 319].

Sorochin 1992: Сорокин, В.Я., 1992. Отчет о полевых исследованиях Трипольской экспедиции в 1991 г. Кишинев. [Archive of the National Museum of History of Moldova, report 336].

Sorochin, V., 1993. Modalităţile de organizare a aşezărilor complexului cultural Cucuteni-Tripolie. *Arheologia Moldovei*, XVI, 69–86.

Sorochin, V., 2002. *Aspectul regional cucutenian Drăguşeni-Jura*. Bibliotheca Memoriae Antiquitatis XI. Piatra-Neamţ: Editura Constantin Matasă.

Telegin, D.Y., Lillie, M.C., Potekhina, I.D. and Kovaliukh, M.M., 2003. Settlement and economy in Neolithic Ukraine: A new chronology. *Antiquity*, 77 (297), 456–470. Available from: DOI:10.1017/S0003598X00092528

Ţerna, S., Rassmann, K., Vasilache, M. and Radloff, K., 2016. Stolniceni I – new research on a Cucuteni-Tripolye large site. *In*: A. Zanoci, E. Kaiser, M. Kashuba, Izbitser, E. and M. Băţ, eds. *Mensch, Kultur und Gesellschaft von der Kupferzeit bis zur frühen Eisenzeit im nördlichen Eurasien. Beiträge zu Ehren zum 60. Geburtstag von Eugen Sava* / *Man, Culture, and Society from the Copper Age until the Early Iron Age in Northern Eurasia. Contributions in Honour of the 60th Anniversary of Eugen Sava*. Tyragetia International 1. Chişinău: Bons Offices, 41–52.

Țerna, S., Vornicu-Țerna, A. and Rassmann, K., 2018. New data on the formation of complex sites in the Western area of the Cucuteni-Tripolye culture. *In*: И.В. Бруяко, Л.В. Носова and Л.Ю. Полищук, eds. Народи і культури нижнього дунаю в давнину. Матеріали Міжнародної науково-практичної конференції (м. Ізмаїл, 23-26 серпня 2018 р.). Ізмаїл: Одеський Археологічний Музей НАН України, Міністерство Освіти і Науки України Ізмаїльський Державний Гуманітарний Університет, 15–25.

Țerna, S., Rassmann, K., Vornicu-Țerna, A. and Müller, J., 2019a. The evolution of dual-chambered updraught kilns on the Cucuteni-Tripolye mega-sites in the 4th millennium BC: a view from Stolniceni. *Godišnjak*, 48, 41–58. Available from: DOI: 10.5644/Godisnjak.CBI.ANUBiH-48.116

Țerna, S., Vornicu-Țerna, A., Hofmann, R., Dal Corso, M., Shatilo, L., Vasilache-Curoşu, M., Rud, V., Knapp, H., Kirleis, W., Rassmann, K. and Müller, J., 2019b. Stolniceni – Excavation results from the 2017 campaign. *Journal of Neolithic Archaeology*, 21, 209–282. Available from: DOI: 10.12766/jna.2019.9

Uhl, R.A., Vasilache-Curoşu, M., Sîrbu, M., Sîrbu, L., Bicbaev, V., Steiniger, D., Zidarov, P., Sava, E. and Hansen, S., 2017. Petreni in der nördlichen Moldaurepublik. Bericht über die Ausgrabungen der Jahre 2011–2013. *Eurasia Antiqua*, 20 (2014), 185–206.

Videiko, M. and Chapman, J., 2020. Ditches. *In*: B. Gaydarska, ed. *Early urbanism in Europe. The Trypillia megasites of the Ukrainian forest-steppe*. Warsaw, Berlin: De Gruyter, 233–236. Available from: DOI: 10.1515/9783110664959-008

Videiko e*t al.* 2015: Видейко, М.Ю., Чепмэн, Д., Бурдо, Н.Б., Гайдарска, Б., Церна, С.В., Рудь, В.С., and Киосак, Д.В., 2015. Комплексные исследования оборонительных сооружений, производственных комплексов и остатков построек на трипольском поселении у села Небелевка. *Stratum plus*, 2015 (2), 147–170.

18. Trypillia settlements after mega-sites: Archaeological and geophysical Investigations in the Cunicea micro-region, Prut-Dniester interfluve

Stanislav Țerna†, Robert Hofmann, Liudmyla Shatilo, Vitalii Rud

Introduction

On the territory between the Prut and Dniester rivers in the western areal of the Cucuteni-Trypillia culture, the climax of mega-site development corresponds to the Petreni and Shypyntsi local groups of the Trypillia B2 and C1 relative-chronological stages or to the period of ca. 3900–3700 BCE. This is the time span when the complex concentric settlements like Stolniceni, Petreni and Trinca existed in Northern Moldova, followed by sites like Soroca-Ozero, Vărvăreuca VIII and XV. From ca. 3600 BCE, important socio-economic changes occur, embodied in profound transformations of settlement layout and material culture. The Bădragii Vechi sites (= Badrazhskaya group) are still large in size, reaching 30–40 ha; nevertheless, the spatial arrangement of settlements no longer seems to display the perfect ring-shaped layout of the preceding centuries and the houses are instead arranged in dispersed groups.

The process of disintegration of the Cucuteni-Trypillia culture gains a dramatic intensity after 3600 BCE, at the Trypillia C2 stage, when several interconnected local groups emerged. According to the classic taxonomy of Dergachev (1980; cf. Manzura 1994; Diachenko and Harper 2016; Diachenko 2019), there are two 'genetic' lines of development of the Prut-Dniester interfluve in this period. One of these corresponds to the Brînzeni type which influenced the formation of other local groups in the Upper Prut, Upper Dniester, Southern Bug and Bug-Dnieper regions. It is considered that this served as the basis for the formation of the Horodiștea-Gordinești-Kasperovcy groups, although there are striking differences in painted pottery ornamentational patterns between Brînzeni and Gordinești

sites. The other line corresponds to the Vîhvatinți type which further influenced the formation of the Usatovo and Folteşti types in the North Pontic steppes and Middle Prut/Lower Danube region.

Dergachev's scheme was later improved by Bikbaev (1994) who addressed the obvious stylistic differences between the Brînzeni and Gordineşti painted pottery, mentioned above. Thus, the Brînzeni assemblage is characterised by curvilinear motifs which represent a further development of Trypillia C1 and C1–C2 ornamental patterns, while the Gordineşti fine ware is notable mainly for its geometrical style which does not resemble the stylistics of the pottery of preceding stages. Bikbaev's surveys in Northern Moldova allowed him to identify a group of sites with mixed curvilinear and geometrical patterns, named Chirileni type.

The package of transformations which occurred in the Cucuteni-Trypillia milieu after 3600 BCE is vast and comprises various manifestations of socio-economic life of the Late Copper Age communities, from settlement position, size and layout to pottery, miniatures and tools. Against this vast background, two phenomena deserve a special mention as they have profound economic and ideological consequences. First, the intensification of distant contacts, exemplified for instance by the Bădragi-type pottery imports in Cernavoda I milieu from the North-West Pontic area (Manzura 2018) or by the occurrence of Brînzeni pottery in Western Volhynia (Rybicka 2017). Secondly, the emergence of extramural cemeteries which have been so far recorded for the Vîhvatinți, Gordineşti, Usatovo and Folteşti groups.

The Cunicea microzone

At the edge of a small-scale quarry of sand or loess loam on a hilltop 1.5 km east of the Cunicea village, several Late Trypillia graves were accidentally discovered some years ago and were considered as a possible extramural cemetery (Topal and Țerna 2010). The pottery recovered from two destroyed graves displayed specific stylistic elements which allowed its attribution to the Gordineşti type. At the same time, a dugout settlement feature from the same location yielded ceramics of the Vîhvatinți type. Hence, the association, within a single site, of two elements – graves with Gordineşti pottery and settlement with Vîhvatinți materials – has been considered extremely promising for a better understanding of the Trypillia C2 mosaics in the region. At the same time they raise the question as to whether this joint occurrence at the same place is the result of repeated occupations or related activities?

In addition, the 2009 field walking in the Cunicea microzone (Fig. 1) allowed us to discover two other Late Trypillia settlements, one of which provided certain Trypillia C2 materials. Thus, the site with Gordineşti graves and Vîhvatinți settlement features has been termed Cunicea 1. The finds of Vîhvatinți pottery to the north from this location, on the slope of the hill, were noted as Cunicea 2. Another settlement with Late Trypillia pottery of unidentified type, located directly to the east of the village, has been noted as Cunicea 3, while a settlement with Vîhvatinți pottery located further to the north from the village has been recorded as Cunicea 4.

The sites described are located in a relatively small area of a few square kilometres, while the surrounding areas of the river catchment are free of sites, according to the information available to date. This unequal site distribution and the discovery of another large Cucuteni-Trypillia settlement Cuşmirca 6 during our field work, located only about 1 km east of Cunicea 1, show that we are probably still at the beginning of our knowledge of the archaeological sources in the investigated region. In this respect, the current state of research does not allow us to draw far-reaching conclusions about the micro-regional settlement pattern and the settlement density of the study area.

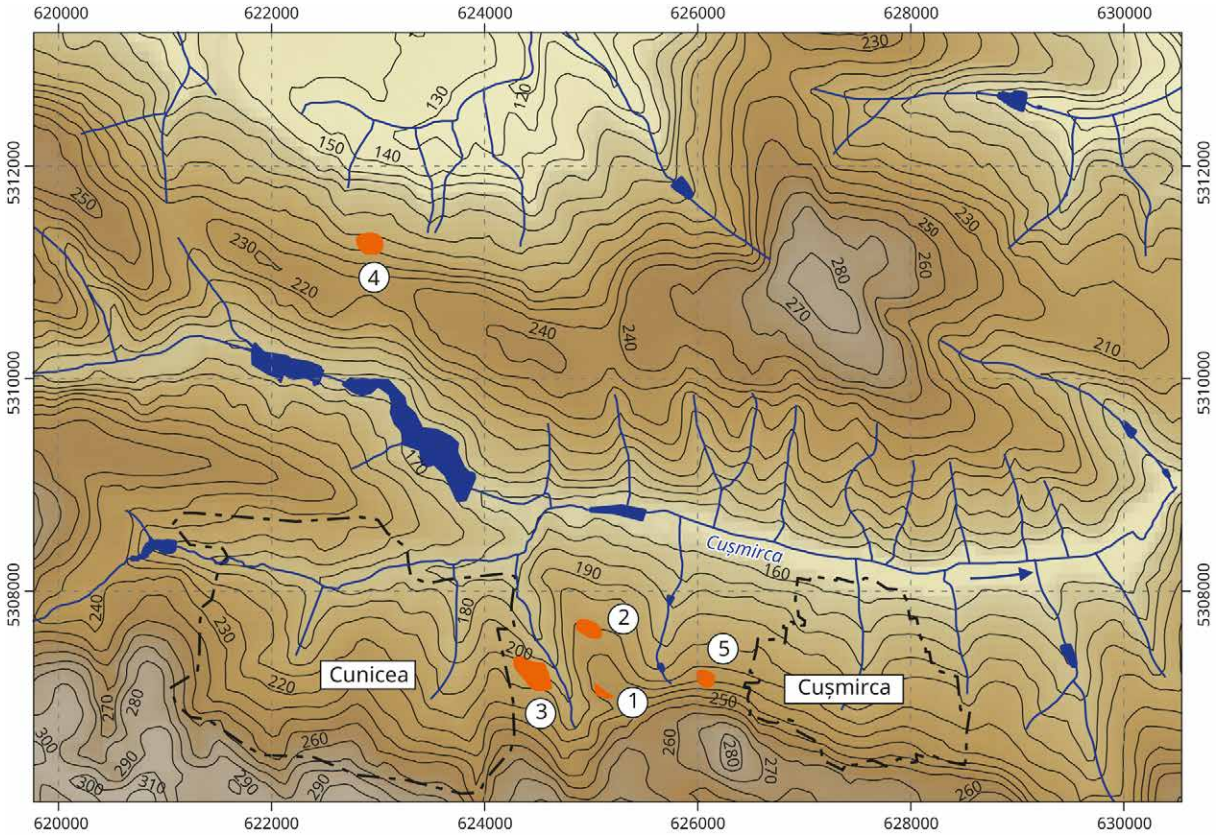


Figure 1. Location of investigated sites. 1 – Cunicea 1, 2 – Cunicea 2, 3 – Cunicea 3, 4 – Cunicea 4, 5 – Cușmirca 6. Gray polygons mark the modern villages (graphic S. Țerna).

Taking into account all the above mentioned considerations, a joint survey was carried out in the spring of 2016, as a result of a cooperation between the 'High Anthropological School' University (Chișinău, Republic of Moldova) and the Institute of Pre- and Protohistoric Archaeology of 'Christian Albrecht' University (Kiel, Germany). The survey had two main objectives: 1. geophysical prospection of the Trypillia C2 sites from the Cunicea microzone and 2. archaeological investigations of certain anomalies from the geomagnetic plots by means of small test trenches in order to obtain materials for both relative and absolute chronological fine dating of the sites surveyed.

The presentation and discussion of the results of this survey constitute the core of the following article.

Geophysical and archaeological survey methods

For the geomagnetic measurements the MAGNETO® MX V3 Survey System of the company SENSYS Sensorik & Systemtechnologie GmbH, Bad Saarow (Germany) was used; this can be utilised in various configurations with up to 16 channels (sensors). The instrument was the property of the Graduate School 'Human Development in Landscapes' and now of the 'Johanna-Mestorf Academy' of Kiel University. During the field work in Moldova the device was installed on a wheel cart pushed by two persons. At the time when the surveys were performed only 11 sensors were available. In order to utilise the fullest possible width only 8 sensors were installed at intervals of 0.5 m and a total width of 3.5 m. The geomagnetic device is coupled with a GPS-system (Leica, GNSS/GPS systems Viva GS 10) enabling continuous grid measurements (zig-zag) in a small amount of time.

No measurement points were available in all surveyed locations which would have enabled the location of the measurements precisely within the national and world coordinate system. Thus, in each case it was necessary to establish local measurement systems with the available Differential GPS System Leica, GNSS/GPS systems Viva GS 10. With this method, our measurements were located in the world coordinate system with a precision of several metres. In order to ensure the possibility of reconstructing the measurement system, fixed points were established and documented. The measurements themselves were performed in UTM coordinate system (zone 35N) and WGS 84 ellipsoid.

Data acquisition, primary data processing, interpolation and export were performed using the SENSYS software package MonMX (v. 4.0), DLMGPS (v. 4.01) and MAGNETO®-ARCH (V3). During export from DLMGPS the automatic track offset correction was turned on. For data export from MAGNETO ARCH we chose the format Surfer grid 7 which delivers raster maps which can be used in GIS-applications, enabling modification of thresholds and colour scale. The standard setting was used which interpolated the measurement results to 0.2 m x 0.2 m raster cells.

For analysing the geomagnetic maps the GIS application QGIS was used. The interpretation of the geomagnetic maps was performed in two different ways. On the one hand, anomalies which could be interpreted more or less confidently such as ditches, (rectangular) remains of burnt houses, or modern disturbances (*e.g.* from power poles) were interpreted and redrawn directly. On the other hand, an automatic classification of the features was performed to interpret also anomalies of less obvious character. Therefore, vector polygons were generated using the threshold value of 2 nT and the GRASS algorithm r.contour level based on the raster grid. For these vector objects different statistical values as average, mean and maximum flux density were calculated. To present the data we chose the mean-nT value.

The test trenches were dug following a classic methodology for Trypillia field investigations. Thus, the removal of earth was done in artificial layers (spits), each corresponding to ca. 20 cm soil depth, on squares of 1 m^2. After contouring the Copper Age features, the excavation was made in 'natural' layers, according to the specifics of the archaeological objects. For burnt house remains, the daub debris was cleaned down to the prehistoric step-surface layer, documented and removed, recording the imprints from the wooden frame of the construction. All the clay was weighed and classified. For dugout features, after reaching sterile soil outside of the pit, it was left untouched and the pit contents (refill layers) were excavated with same 20-cm spits down to the bottom. For the horizontal plana, a combination of hand drawing and digital photogrammetry was used, while the profiles were recorded only by photogrammetric means. The exact positions were measured for all the single finds and samples.

Results

Cunicea 1

Site location and history of research

The site is located about 1 km east of the eastern outskirts of Cunicea village, in the place locally named as 'Prișanskaia Gora', on the top of a hill bordered by a deep and rather steep valley of an unnamed brook, a right tributary of the Cușmirca stream (part of the Dniester fluvial system; Fig. 1). The site was discovered in 2007 by D. Topal who, at the bottom and in the wall of a recent clay pit, identified late Trypillian

ceramics and human bones, which proved to be the first partly destroyed grave known of the Gordinești type (Topal and Țerna 2010). The skeleton was lying on its left side, on the SW-NE axis, with the legs bent at the knees. The preserved inventory consisted of nine vessels placed in the head area. The vessels belonged both to fine (painted) and coarse categories (Fig. 2: 1–10).

In 2009, the site was visited by S. Țerna and D. Topal. The examination of the clay pit allowed the identification of a second destroyed grave and a large pit in the southern wall of the quarry (Topal and Țerna 2010; Țerna 2011). In the grave, the skeletal remains were missing except for some small bones; from its inventory, two vessels were preserved in the clay pit profile (Fig. 2: 11–12). In 2012, S. Popovici and I. Ceban carried out rescue investigations that unfortunately did not provide new Copper Age graves. At the same time, one of the trenches was located on the dugout feature observed in 2009 (Fig. 2: 13–27). It was unearthed partially, until a modern farm road was reached. The pit had an imposing length of 11.5 m and a maximal width of ca. 3 m in the part investigated. A medieval tomb was discovered in the eastern part of the clay pit (Popovici and Ceban 2014a; Popovici and Ceban 2014b).

Unfortunately, neither the 2009 nor 2012 field investigations could answer some crucial questions regarding the Late Copper Age features from Cunicea 1 (see the Introduction above). These are: 1. the planigraphy and content of the Vîhvatinți type deposits; 2. the planigraphy and content of the Gordinești type deposits; 3. the interrelation between them. Attempting to answer these questions, we conducted geophysical surveys and opened three small test trenches over some of the identified anomalies.

We should mention that the visual inspection of the clay pit from 2016 allowed us to notice several other human bones dispersed over the area. All these definitely come from destroyed Copper Age or Medieval graves. Unfortunately, no funerary features were observed in the walls of the quarry.

Geophysical survey

The archaeomagnetic surveys in Cunicea 1 were carried out on an area of about 2.24 hectares, around the clay extraction pit and on the northern slope of the hill (Fig. 3). As a result, anomalies of two types were detected (Figs. 4, 5): 1. an elongated anomaly oriented on the NW-SE axis, which most likely represents the unexcavated part of the deepened structure with pottery of the Vîhvatinți style investigated in 2012; 2. North of the clay quarry a row of weakly visible rectangular structures of house ground plans were detected. This row of houses runs uphill from NW to SE; the most southeastern one is located on the top of the hill. The long axis of these anomalies is oriented SW-NE; their dimensions vary between 12–17 m (length) and 6–9 m (width). In total, six such house anomalies could be recognised. Numbered from northwest to southeast, anomalies № 1, 2 and 6 are more visible on the geophysical plot, while anomalies № 3–5 display a lower intensity (Figs. 2–4). The more visible house features consist of roughly rectangular zones, which are delimited by linear anomalies with an average width of 1.5 m and magnetisation (flux density) between 0 and 10 nT.

Note that anomaly № 6 partially interferes with the northern limit of trench № 1 from the 2012 rescue excavations (Popovici and Ceban 2014a). Out of the three trenches opened at that time in the northern bank of the clay pit, only this trench provided two small agglomerations of undecorated Trypillian pottery. Taking into account this fact and considering the configuration of the anomalies from the geophysical plot, we interpreted the rectangular anomalies as remains of light surface dwellings within the Vîhvatinți settlement. To test this hypothesis, we carried out several trial excavations.

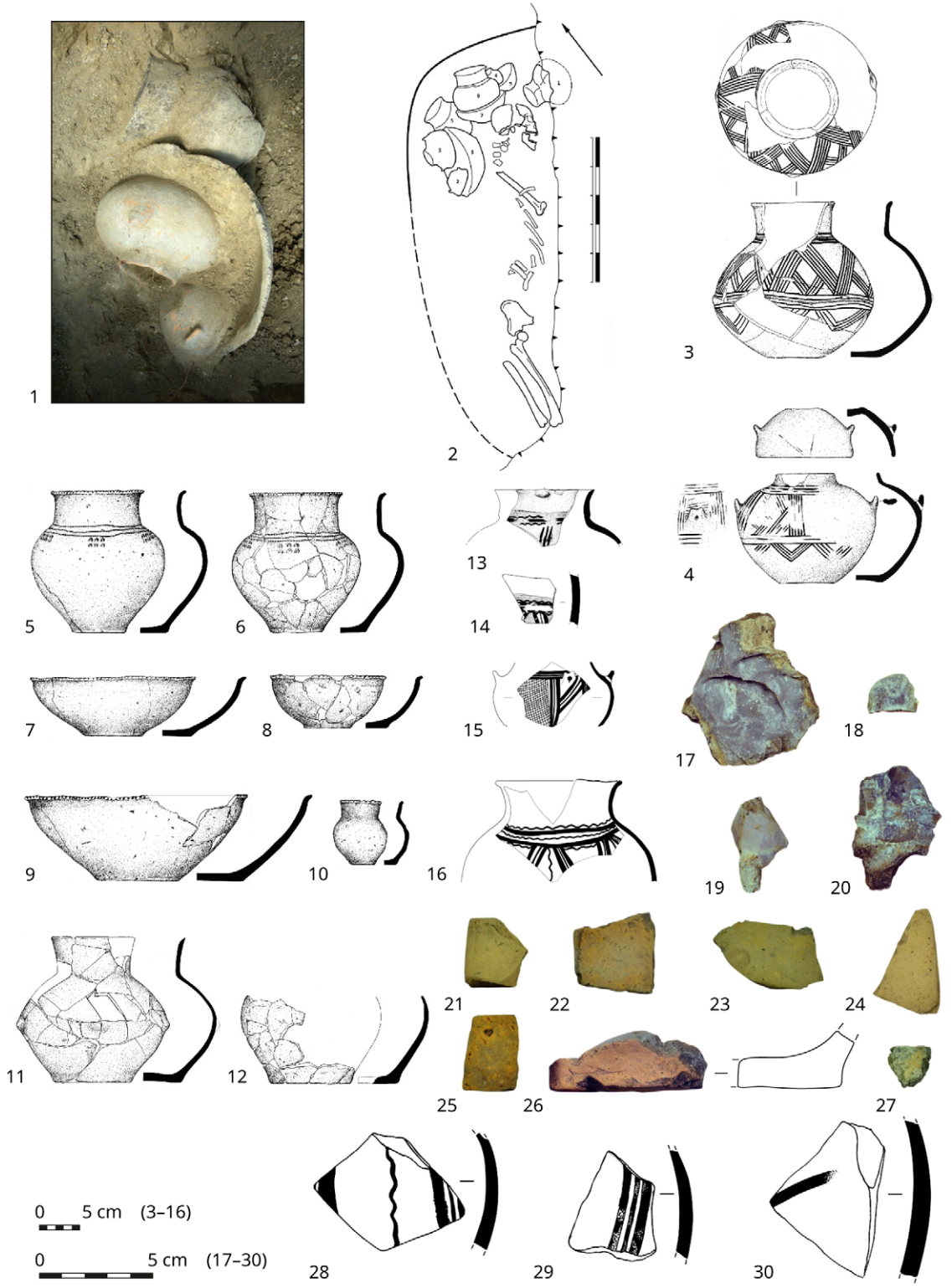


Figure 2. Materials from Cunicea 1 and Cunicea 2 sites. 1 – photo of vessels from grave № 1/2007 at Cunicea 1 site (photo D. Topal); 2 – plan of the grave № 1/2007 at Cunicea 1 site (after Topal and Țerna 2010); 3–10 – pottery from grave № 1/2007 at Cunicea 1 site (after Topal and Țerna 2010); 11–12 – pottery from grave № 2/2009 at Cunicea 1 site (after Topal and Țerna 2010); 13–14 – pottery from the 2009 investigations of the dugout feature at Cunicea 1 site (after Topal and Țerna 2010); 15–16 – pottery from the 2012 investigations of the dugout feature at Cunicea 1 site (after Popovici and Ceban 2014b); 17–27 – surface finds from 2016 survey at Cunicea 1 site (photos S. Țerna); 28–30 – surface finds from Cunicea 2 site (after Topal and Țerna 2010).

Test trenches

The three test trenches were located on the anomalies with higher intensity, namely № 1, 2 and 6, approximately over one of the long sides of each anomaly (Figs. 3–5).

Test trench № 1 was located on the western side of anomaly № 1 and was oriented SW-NE. Its dimensions were 2 × 2 m. The respective anomaly is the marginal one in the row, located below the others, down the slope. The trench was excavated to a depth of almost 1 m. The stratigraphy is as follows: 0–27/35 cm: semi-compact alluvial sandy-clayish sediment, light-brown, with tiny inclusions of burnt clay; 27/35–38 cm: semi-compact alluvial sandy-clayish sediment, dark-brown, with small inclusions of burnt clay; below 38 cm: sterile yellow clay. Unfortunately, no clear archaeological features could be recognised despite successive cleaning of plana. It is probable that the dark-brownish sediment with some dispersed burnt clay represents everything left of a heavily eroded surface dwelling. This tiny layer may be connected to the substructure of the dwelling (foundation trench?). Except for some massive animal holes, no other soil changes could be observed.

Despite the lack of recordable features, the trench revealed massive layers of alluvial sediments which probably covered the settlement remains. In order to clarify this, we decided to place other test trenches over the row of anomalies up the slope.

Thus, test trench № 2 was located on the western side of anomaly № 2 and was oriented SW-NE. Its dimensions were of 1 × 2 m. The trench was excavated to a depth of about 60 cm. The stratigraphy is as follows: 0–25 cm: semi-compact alluvial sandy-clayish sediment, light-brown, with tiny inclusions of burnt clay; 25–32 cm: semi-compact alluvial sandy-clayish sediment, dark-brown, with small inclusions of burnt clay; below 32 cm: sterile yellow clay. In the western part of the test trench, on Plana 2 and 3 (depths of 40 and 60 cm), the contour of a dugout feature was identified. It consisted of semi-compact sandy dark-brown clay with tiny inclusions of daub and measured 80–85 × 40–60 cm. We consider that this feature represents the remains of the foundation structure of an above-ground dwelling, since the location of the dark spot perfectly matches one of the sides of the rectangular anomaly from the geophysical scan (Fig. 6).

Test trench № 3 was located on the eastern side of anomaly № 7, located near the top of the hill. Its dimensions were 2 × 2 m. The survey was taken to a depth of ca. 40 cm. The stratigraphy is as follows: 0–20/23 cm: layer of black soil mixed with sandy clay, semi-compact, with tiny inclusions of burnt clay; 20/23–32 cm: semi-compact alluvial sandy-clayish sediment, dark-brown, with small inclusions of burnt clay; below 32 cm: sterile yellow clay. Cleaning of the surface at a depth of about 25 cm allowed the identification of several features. Three of them turned out to be anthropic and two others were related to bioturbation. Among the anthropic features, one was a modern ploughing trench (Feature 5003) while the other two represented dark spots, elongated on the SSW-NNE direction, with a width of about 40 cm and an investigated length of ca. 80 cm (Features 5004 and 5005). Each of these spots had a depth of about 10 cm. Their fill consisted of semi-compact sandy dark-brown clay with small daub inclusions. We consider these features to represent the remains of the foundation structure of an above-ground dwelling, perfectly matching one of the sides of the rectangular anomaly from the geophysical scan (Fig. 7).

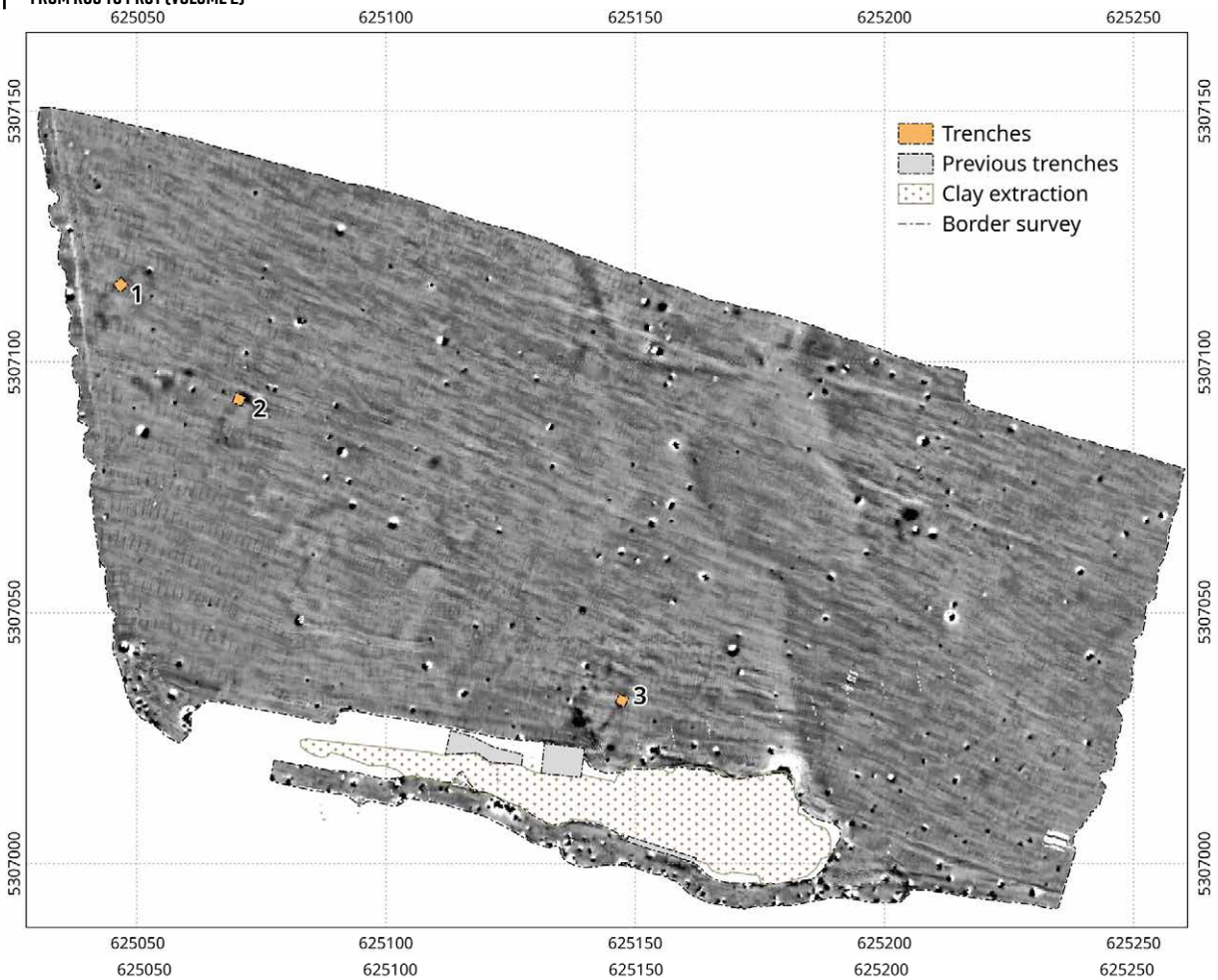
Except for a small quantity of burnt clay, no archaeological finds were obtained from the test trenches. Some flint flakes and pottery fragments were however collected from the surface in the area of the rectangular anomalies (Fig. 2: 17–27). None of the shards were diagnostic and they come primarily from vessel walls. One single piece stems from the vessel base. Despite the lack of decoration and morphological traits, the clay paste, firing and colour undoubtedly indicate a Trypillia C2 dating. However, they do not allow the identification of a particular pottery style.

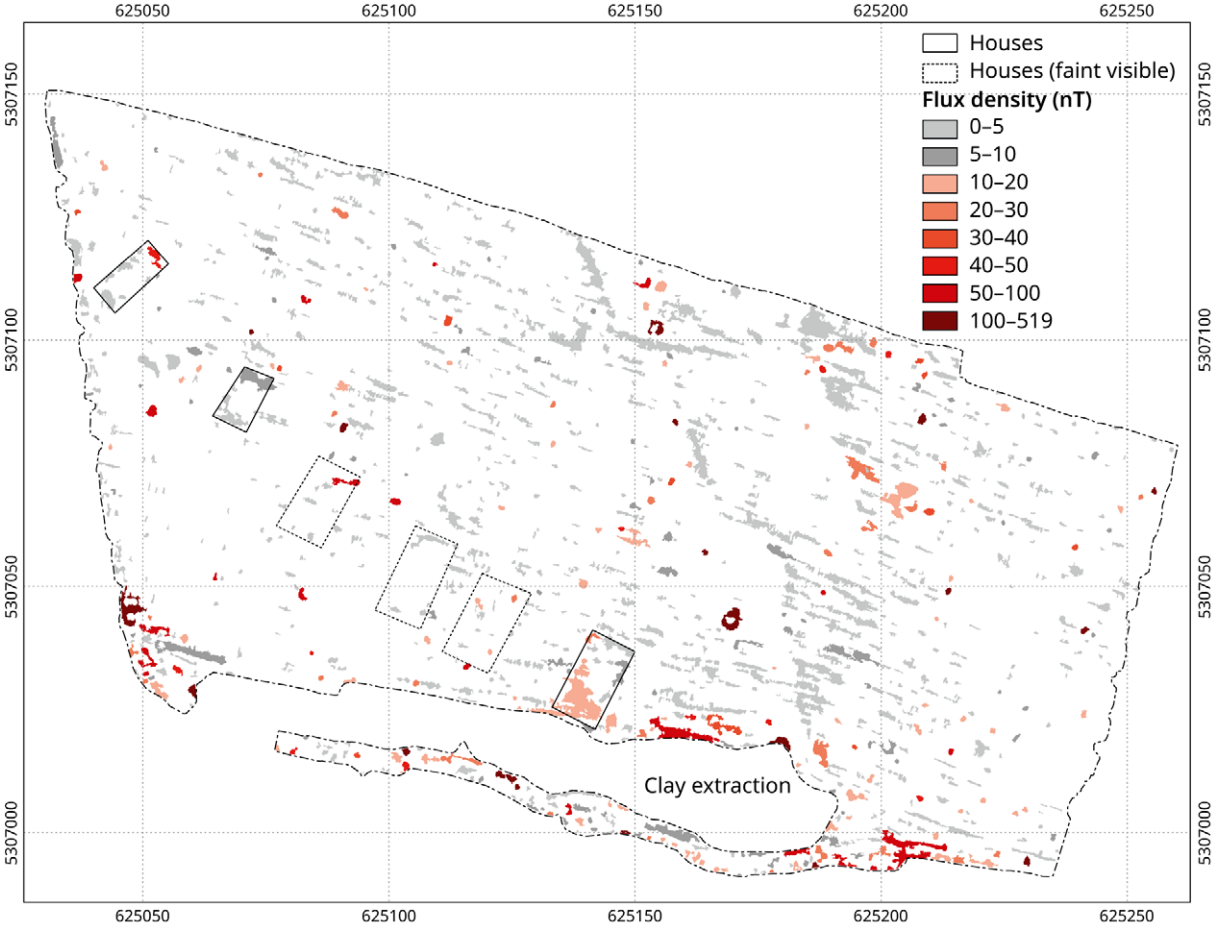
Figure 3 (following pages, top left). Geophysical plot of Cunicea 1 site and locations of the trenches 1–3 (graphic R. Hofmann).

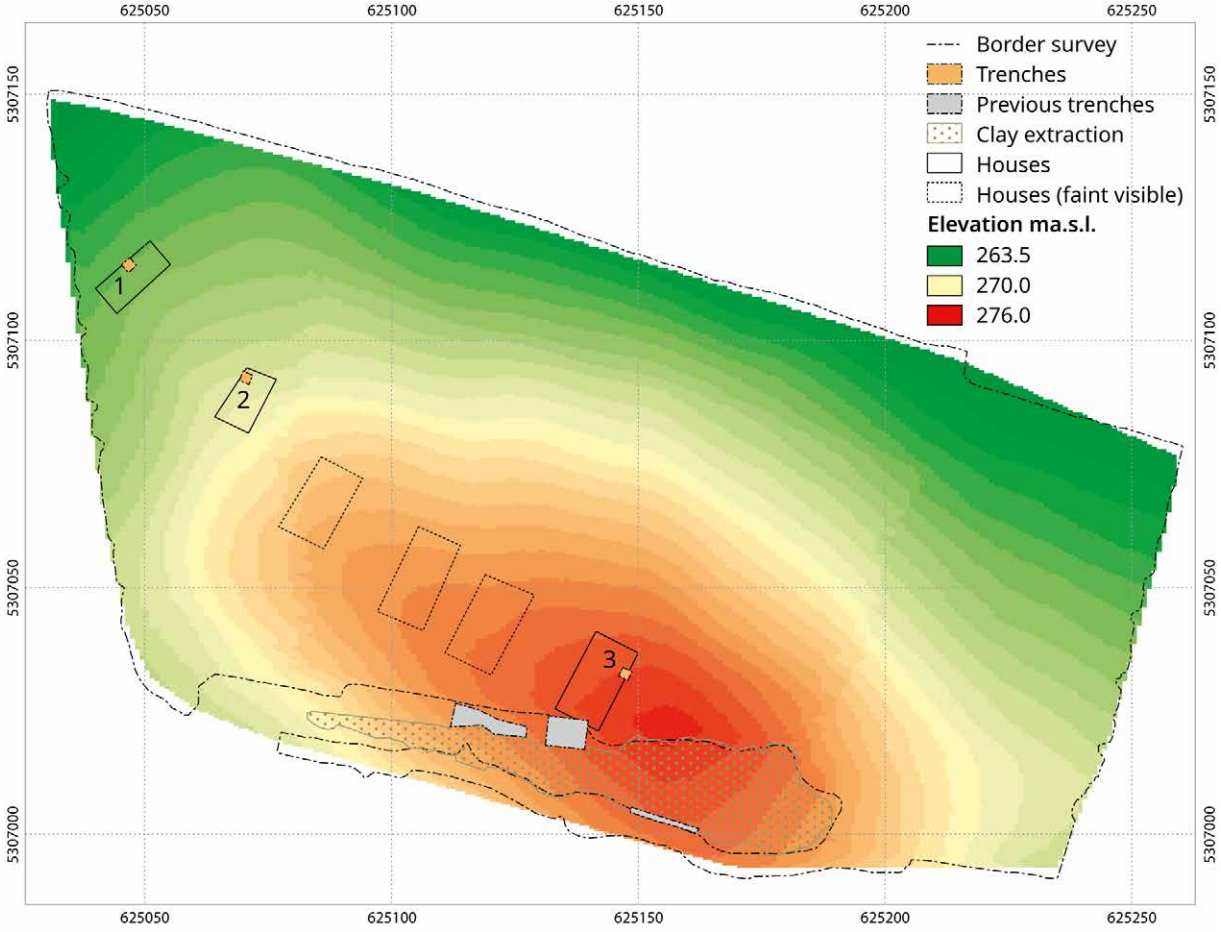
Figure 4 (following pages, bottom left). Classification of anomalies from the geophysical plot (graphic R. Hofmann).

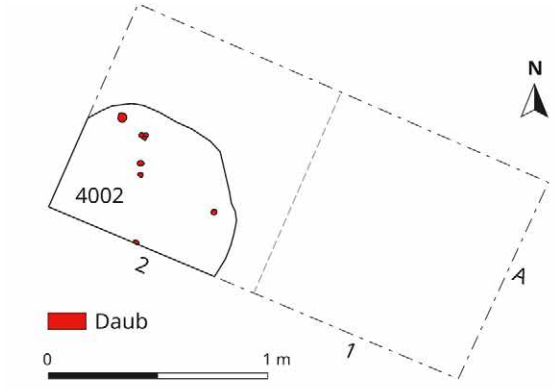
Figure 5 (following pages, top right). Interpretation of the geophysical plot (graphic R. Hofmann).

Figure 6 (following pages, bottom right). Test trench № 2 from Cunicea 1 site – plan, photo (depth 40 cm), geophysical context (graphic S. Țerna, V. Rud).

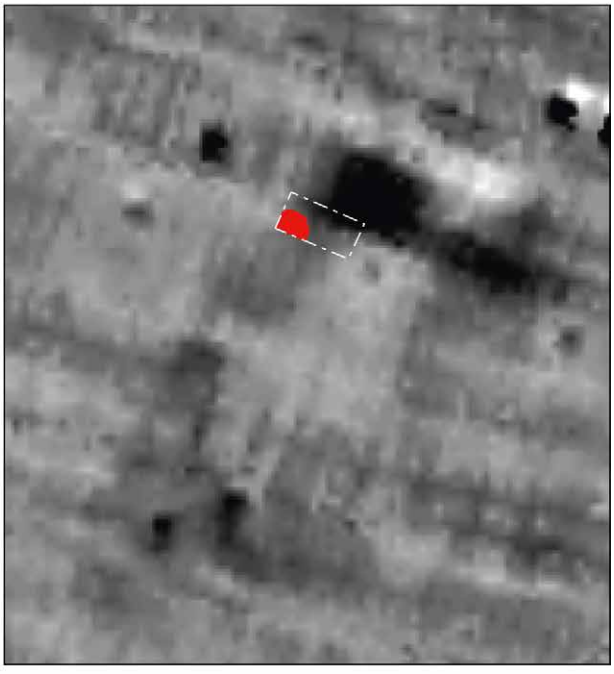

625050
625100
625150
625200
625250
5307150
5307100
5307050
5307000
Trenches
Previous trenches
Clay extraction
Border survey
1
2
3

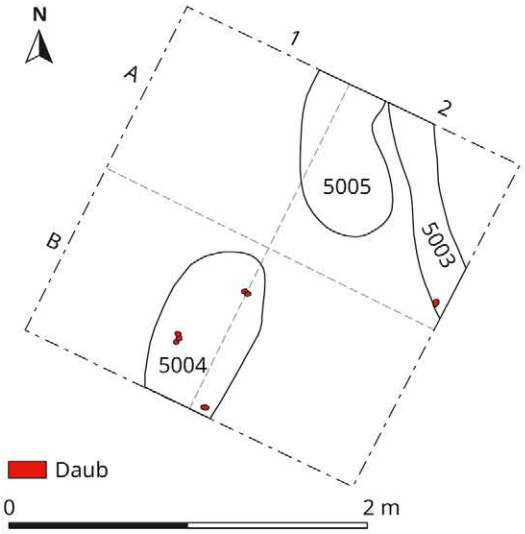

625050
625100
625150
625200
625250
5307150
5307100
5307050
5307000
Houses
Houses (faint visible)
Flux density (nT)
0–5
5–10
10–20
20–30
30–40
40–50
50–100
100–519
Clay extraction

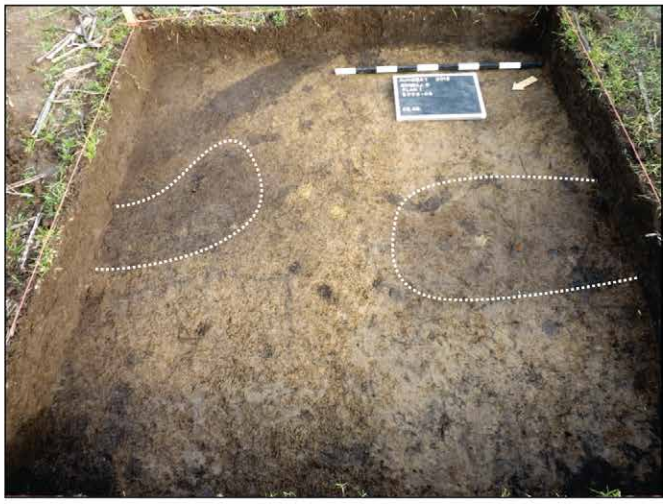

625050
625100
625150
625200
625250
5307150
5307100
5307050
5307000
Border survey
Trenches
Previous trenches
Clay extraction
Houses
Houses (faint visible)
Elevation ma.s.l.
263.5
270.0
276.0
1
2
3


N
4002
2
4
1
Daub
0
1 m




0
2 m







Site	Laboratory sample ID	^{14}C age	N (%)	C (%)	col (%)	δ^{13}C (‰)	δ^{15}N (‰)	Find ID	Feature ID	Level	Find x
Cunicea 1	Poz-87485	4585 ±35		0.7				3002	3003	3	A-B
Cunicea 1	Poz-87486	-2303 ±22						4001	4002	2	A
Cunicea 4	Poz-87487	4495 ±35	2.9	8.9	8.8			7070	7006	7	A
Cunicea 4	0	>0	<0.1	1.5				7042	7005	5	B
Cunicea 4	0	>0	<0.1	0.1				7068	7006	6	A
Cunicea 4						20.7	11.0	1001			

^{14}C dating

Since no bones were found in our excavations, two seeds from botanical samples were dated from the site Cunicea 1, of which, however, only the sample Poz-87485 dates to the Trypillia period (Tab. 1). The botanical sample was taken from a cultural layer below the present top soil (Feature 3003) in Trench 1 and dates the northwestern-most house of the house row.

The dating falls in a period where the calibration curve is characterised by an extended wiggle (3520–3365 BCE), a short steep area (3365–3340 BCE) and an extensive plateau (3340–3100 BCE; Fig. 8a and b). With the highest probability (44%) the dating falls into a steep section of the calibration curve and dates in the 34th century BCE. However, a dating in the first half of the 35th century (23.9%) or 33rd/32nd century (27.3%) cannot be ruled out.

Botanical macro remains

From contexts of the Cunicea 1 site, a total of four soil samples from the three trenches were examined for botanical macro remains, all of which proved to be extremely poor (Tab. 2). In the sample with the Find-ID 3002 in Trench 1 a charred seed of *Sambucus ebulus* and two twisted awn fragments from feathergrass (*Stipa* sp.) were found. In addition to particles of charcoal, an emmer grain originates from the sample with the Find-ID 4001 from Trench 2, which, however, proved to be modern by ^{14}C dating. Sample 4002 from the same trench contained only small charcoal particles. From Sample 5001 from Trench 3 a cereal grain of unknown species (Cerealia indet.) was obtained.

Discussion

Our investigations at the Cunicea 1 site show the existence of a row of ground-level houses running in a northwest-southeast direction and substantiate the finding of extensive late Trypillia-age settlement activities at this site, which is unusual, given its topography on a hilltop. These settlement activities most probably took place in the 34th century BCE. Unfortunately, it remains unclear in which functional and chronological relationship the newly discovered above-ground houses stand to settlement pits and graves observed during earlier research. We also do not know whether the settlement extended further south, where it could have been destroyed by the clay extraction or partly covered by forest.

Unfortunately, the surveys did not yield any geophysically-discernable traces of grave pits. Both graves investigated in 2007 and 2009 had a specific ‘clay-in-clay’ stratigraphy with the refill displaying just a slight chromatic difference to the sterile soil. This definitely did not yield a geophysical intensity strong enough to be ‘captured’ during our survey. It is probable that there are more graves in the area and their non-invasive detection should be made using other techniques.

Figure 7 (opposite page, above). Test trench № 3 from Cunicea 1 site – plan, photo (depth 25 cm), geophysical context (graphic S. Țerna, V. Rud).

Table 1 (below). ^{14}C samples from Cunicea 1 and 4. Context and results.

Find y	Trench ID	Sample material	Taxon	Laboratory remarks	^{14}C sample material details	^{14}C context description
1	1/2016	seed	*Sambucus ebulus*			house
2	1/2016	grain	*Triticum dicoccum*	133.2 ± 0.36 pMC, modern		house
1	1/2016	bone	not identified		16g	pit filling
2	1/2016	bone	cattle	not suitable	14g	pit filling
1	1/2016	bone	catte	not suitable	45g	pit filling
	1/1976	bone	*Cervus elaphus*		antler	burnt dwelling no. 2, -70-90, South-100, East-60

Figure 8a.

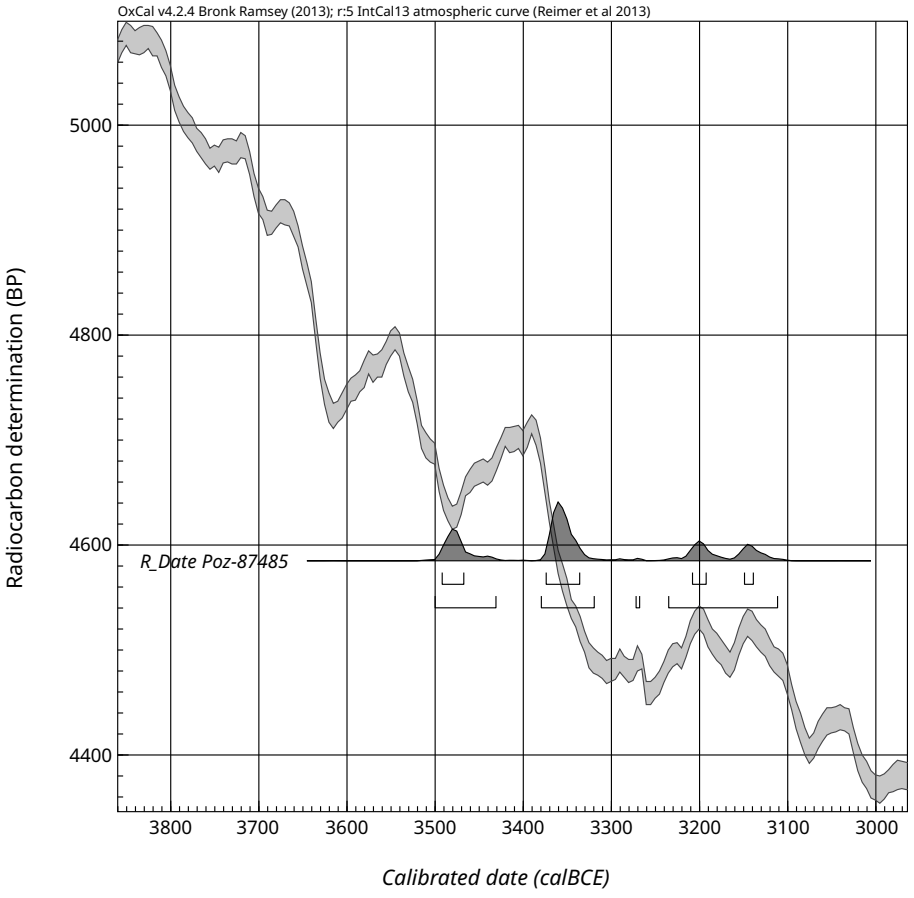
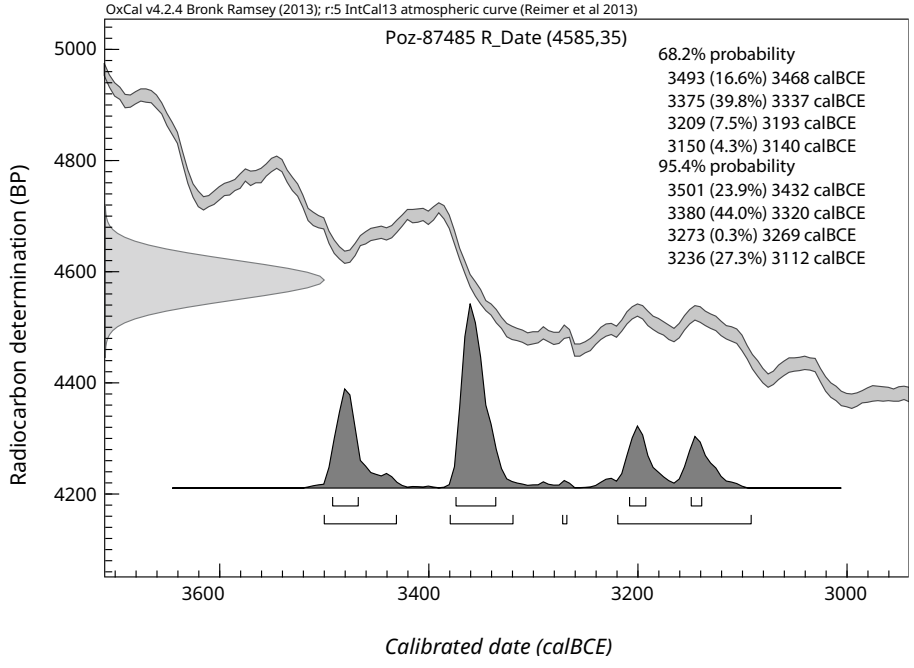


Figure 8b.



Figures 8a and 8b. Cunicea 1. Calibration result of the Radiocarbon date Poz-87485 from trench № 1 at Cunicea I site.

Site	Find-ID	Trench	Feature-ID	Level	Grid x	Grid y	Date
Cunicea 1	3002	1	3003	3	A–B	1	06.03.2016
Cunicea 1	4001	2	4002	2	A	2	06.03.2016
Cunicea 1	4002	2	4002	3	A	2	06.03.2016
Cunicea 1	5001	3	5001	1	B	1	06.03.2016
Cunicea 3	1012	1	1003	4	B	1	05.03.2016
Cunicea 3	1013	1	1003	4	B	2	05.03.2016
Cunicea 3	2007	2	2004	4	B	2	03.03.2016
Cunicea 3	2008	2	2004	4	B	1	03.03.2016
Cunicea 4	7025	1	7004	4	B	2	07.03.2016
Cunicea 4	7054	1	7005	5	A	1	07.03.2016

Table 2. Botanical samples in the sites Cunicea 1, 3 and 4. Context description.

On the other hand, the surveys clarified the situation regarding the Vîhvatinți settlement. It consisted of both above-ground dwellings and deepened features, perhaps pits associated to the houses, clearly interfering with the location of the graves. Comparing the stratigraphy of the 2012 trench and the three test trenches from 2016, it may be seen to change down the slope of the hill (Fig. 9). Thus, the topmost trenches (the one from 2012 and trench № 5/2016) had a top layer of black soil, while the other two trenches located further to the north (№ 3–4/2016) lacked this black layer, displaying instead alluvial sediment strata. This means that the slope of the hill has been completely eroded, probably in modern times after deforestation and the start of intensive agricultural use. Subsequently, the water flowing northwards from the top of the hill brought – and continues to bring – sediment soil down, thus washing away completely the black soil on the slope. Respectively, except for shallow remains of foundation trenches, all the architectural components and inventory of the above-ground dwellings have been swept away. The Trypillia C2 dating of these above-ground constructions (probably light ones, without the massive daub layers characteristic for previous stages) is proposed, both by the surface finds, spatial layout and, most importantly, the radiocarbon dating from Trench 3.

To conclude, the Vîhvatinți settlement seems to be completely destroyed and is not suitable for further archaeological investigations. As regards the burials, there is some possibility that their distribution stretches beyond the clay pit and that some graves are still intact.

Cunicea 2

Site location and history of research

The site of Cunicea 2 is located about 700–800 m north of Cunicea 1, on the slope of the hill. It was discovered in 2007 by D. Topal (Topal and Țerna 2010), who collected late Trypillian pottery of Vîhvatinți type (Fig. 2: 28–30), noting the presence of burnt clay fragments at the terrain surface that could have originated from dwelling structures. The site was considered a possible settlement related to the cemetery Cunicea 1 on the hilltop.

Geophysical survey

In the area of these surface finds, attempts were made to localise the site more precisely by means of 8 to 17 m wide archaeomagnetic transects (Fig. 10). In total, an area of about 1.5 ha was investigated, but no potentially archaeologically relevant anomalies could be identified.

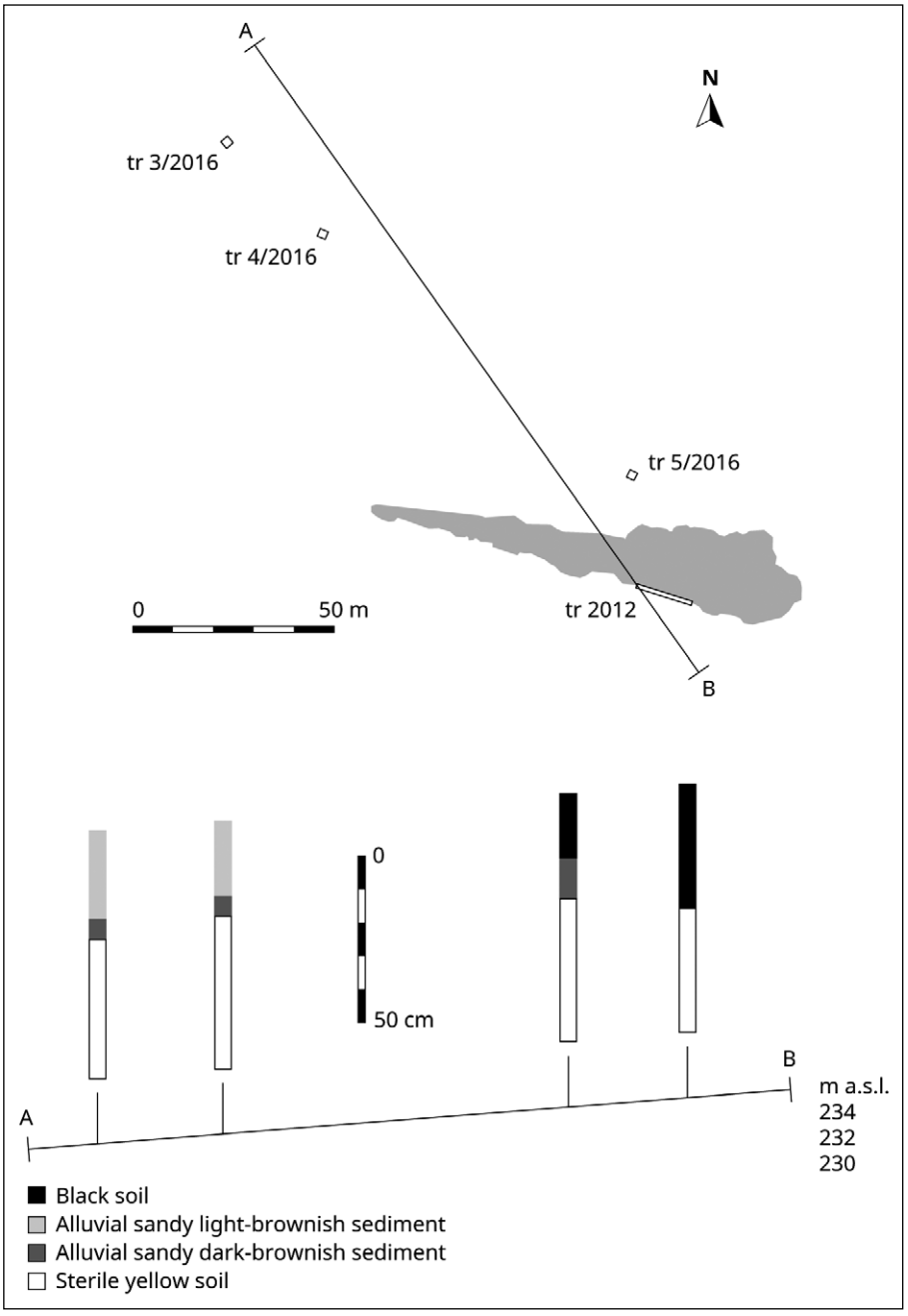


Figure 9. Schematic representation of the stratigraphy in the four excavation trenches at Cunicea 1 (trench of Popovici and Ceban from 2012 over the dugout feature and our trenches from 2016 over the rectangular anomalies). Note the disappearance of the black soil down the slope and its change with alluvial sediment, witnessing heavy erosion of the area and dislocation of sediment by water flowing from the top of the hill. These processes removed completely the above-ground and the prehistoric step-surface features of the Trypillia C2 settlement, leaving just small portions of dugout foundation trenches of the houses, observed in the geomagnetic plot (graphic S. Țerna).



Figure 10. Geophysical plot of Cunicea 2 site (graphic R. Hofmann).

Discussion

Since the geophysical survey did not allow the identification of anthropogenic complexes, it cannot, by analogy with the situation at Cunicea 1, be excluded that the site is completely eroded and covered by sediment.

Cunicea 3

Site location and history of research

The site is located about 200 m eastwards from the eastern outskirts of the Cunicea village, on the gentle slope of the valley of an unnamed stream, a right tributary of the Cuşmirca River. It was discovered by S. Țerna and D. Topal in 2009 (Topal and Țerna 2010), when several undecorated ceramic fragments were collected. The technological parameters of the pottery allowed the preliminary dating of the settlement to the middle or late stages of the Cucuteni-Trypillia culture.

Geophysical survey

The geophysical survey at Cunicea 3 covered an area of about 8.68 ha (Figs. 11–13). As a result, four types of anomalies were identified: 1. high intensity rectangular anomalies of burnt dwelling (burnt dwellings, n = 20); 2. low intensity rectangular anomalies of partially eroded or less heavily burnt dwellings (n = 26); 3. circular or oval anomalies of smaller dimensions with high intensity of burnt clay installations or with daub-filled pits (n = 4); and 4. circular/oval anomalies of smaller dimensions with lower intensity which most likely represent pits (n >35).

The anomalies mentioned are distributed at the gently northeast-sloping plateau that is delimited by a small stream in the east and a water spring in the northeast. In the north, west and south, the demarcation of the settlement area is much more

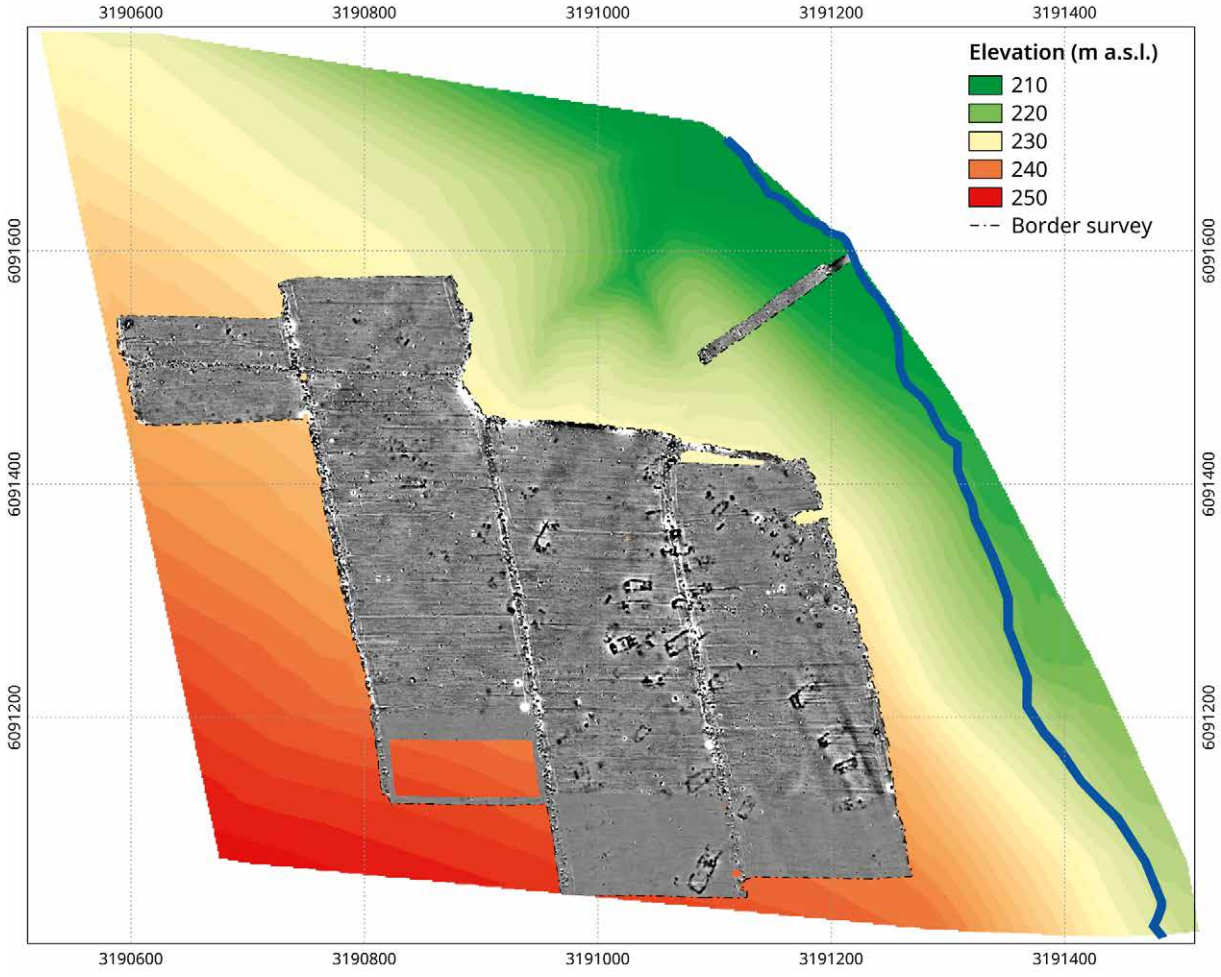


Figure 11. Geophysical plot of Cunicea 3 site and digital elevation model (graphic R. Hofmann).



Figure 12. Classification of anomalies from the geophysical plot (graphic R. Hofmann).

difficult to identify since the site was not confined by a ditch and the density of the anomalies is relatively low towards the edge of the settlement. With a reliable probability the limits of the settlement have been reached in the west and north. In contrast, the southern border of the settlement was not included in the surveyed area as time was limited and only partial authorisation from the landowners prevented the completion of the survey in full.

Within the area investigated the density of the anomalies varies considerably. House remains are concentrated on an area of 6 ha in two groups in the spur-like area south of the spring. Each of these groups exceed an area of about 150 × 120 m; in the centre of the settlement area an interference zone is located where houses of both groups are situated. Inside both groups areas without house features are located remaining on unbuilt zones in the interior space of concentric Trypillia settlements.

However, these unbuilt zones are not surrounded by houses of all orientations as seen in typical ring-shaped Trypillia settlements. Instead, most of the houses are uniformly oriented in a range from east-west to north-northeast to south-southwest. Besides some east-west aligned houses, houses with north-northeast to north-east orientations (25–45 degrees) predominate in the northern group (Fig. 14a). Again, with some exceptions, the houses of the southern group, on the other hand, tend to be oriented more in the range of northeast to east-northeast (45–75 degrees).

The size of the dwelling ranges from 3.3–9 m (width) to 7–26 m (length) and floor areas from 60 to 200 m² with a maximum of 100 m² (clear visible house features) and 60 m² (less clear house features; Appendix: List 2). Smaller houses are concentrated rather at the edge of the settlement, while larger ones are clustered

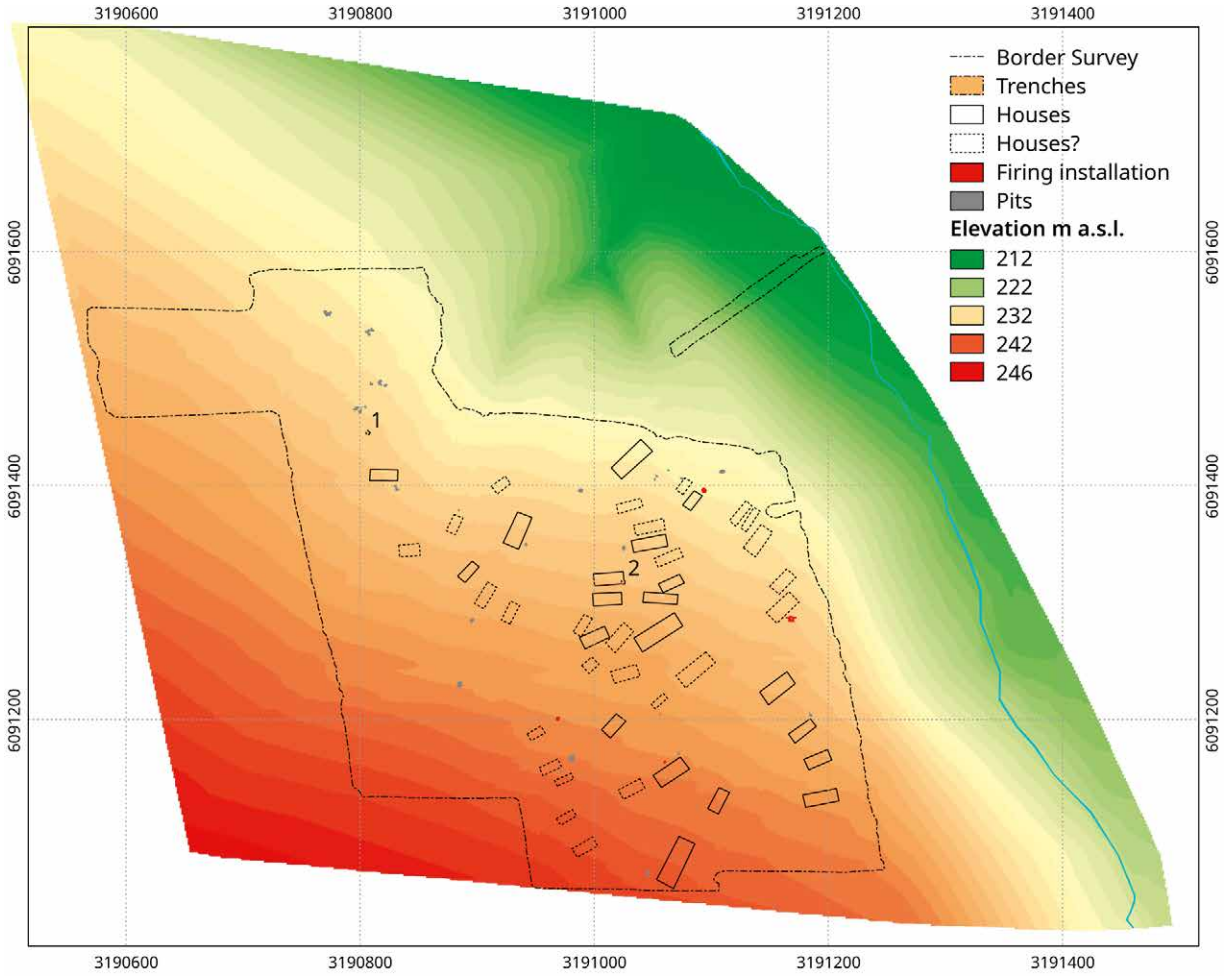


Figure 13. Interpretation of the geophysical plot (graphic R. Hofmann).

in the interference zone of the two groups of buildings (Fig. 14b). Different size categories are represented in both house groups.

Apart from the size and orientation, the intensity of magnetisation of the house remains varies within the settlement considerably. The maximum measured flux density[1] of the house features ranges from 5–10 to 65–75 nT (Fig. 14c). House remains with higher magnetisation are clearly concentrated in the northern house group and the interference zone, while they are missing from the southern group.

Much more clearly visible than in Cunicea 1 is the construction of the houses with highly magnetic zones along the outer walls and much lower magnetised interior zones. There were no typical Trypillia *ploschchadki*, whose massive platforms caused a high magnetisation of the inner surface too (cf. Pickartz *et al.* 2019). Instead, internal subdivisions appear in different variants, usually separating a smaller or larger anteroom from a larger main room (Fig. 15). In most cases the magnetic anomalies of the gable walls are more massive than those of the longitudinal walls.

The intra-site distribution of the different floor plan variants is unspecific insofar as these variants occur in both house groups (Fig. 14d). Subdivided floor plans

1 In contrast to other Trypillia sites with extensively burnt *ploschchadki*, automatic classification of median and mean values for these house anomalies is not reasonable since only a small part of the total floor area contains burnt remains. The resulting values would be significantly lowered because of this characteristic of the anomalies and not comparable with those of other sites. Due to the location of several features in areas which are polluted with metal, the same is true for maximum values. Thus, classification of maximum values of anomalies had to be determined manually according to the maximum values determined from contour level maps. Therefore, in particular, high values which might represent metal have been excluded insofar as they are situated in obviously polluted areas.

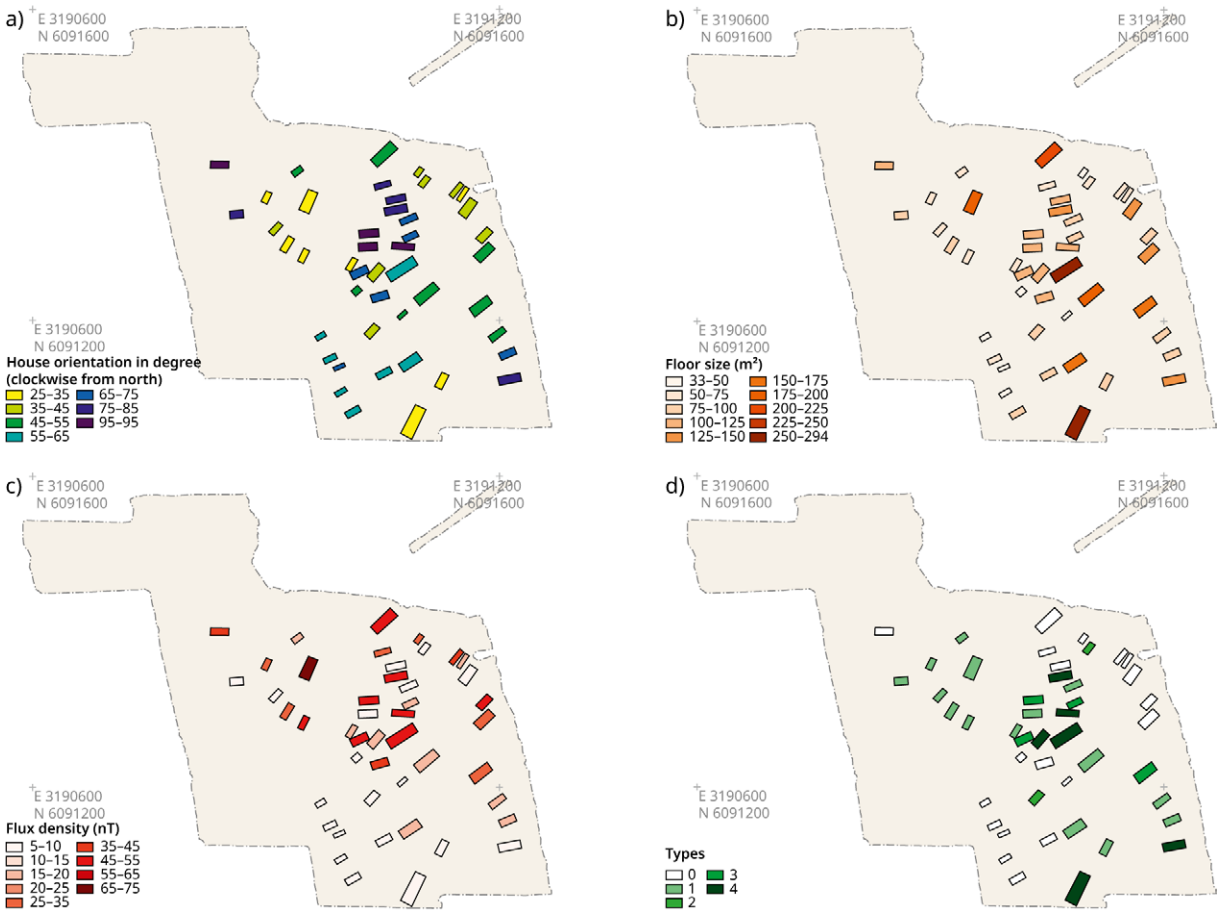


Figure 14. Cunicea 3. Properties of house anomalies: (a) orientation; (b) floor size; (c) flux density; (d) type of ground plan (graphic: R. Hofmann).

with two rooms are more frequent in larger houses, which are concentrated in the interference zone in the centre of the settlement. In contrast, smaller, unstructured floor plans seem to dominate towards the fringes of the site.

Other categories of anomalies show no specific locations within the settlement. Between the houses there are numerous anomalies of pits, which usually do not exceed a size of several square meters (diameters 0.9–3 m) and show very low intensities (magnetisation). However, pits are not as clearly visible as elsewhere due to numerous disturbances and geologically caused lower contrast of the ground. Comparable regular distribution patterns of pits, such as those found in settlements in northwestern Moldavia (Țerna *et al.* 2019) or in the Bug-Dnieper interfluve (Rassmann *et al.* 2014; Ohlrau 2015), can therefore not be identified in Cunicea 3.

A wide distribution in different parts of the settlement also shows four smaller round anomalies with high magnetic intensities between 40–100 nT (Fig. 16). Without archaeological excavation it is unclear whether these anomalies with diameters between 1.5 and 3.0 m represent pits filled with daub, small-scale burnt clay deposits or perhaps remains of installations (*e.g.* pottery kilns).

In the northwestern part of the site there is a cluster of deepened features, some of which show a linear layout. These may represent remains (foundation trenches?) of Copper Age surface constructions or post-Chalcolithic features (shards dated to early centuries CE or medieval times have been sporadically found on the site's surface; Figs. 11–13). Four strips of partly much stronger anomalies run from North to South in the surveyed area. Since these lines correspond with modern field roads, they are most likely to be the result of pollution from discarded metal. Corresponding anomalies occur also at the edge of valley head which is nowadays used as an uncontrolled dump site.

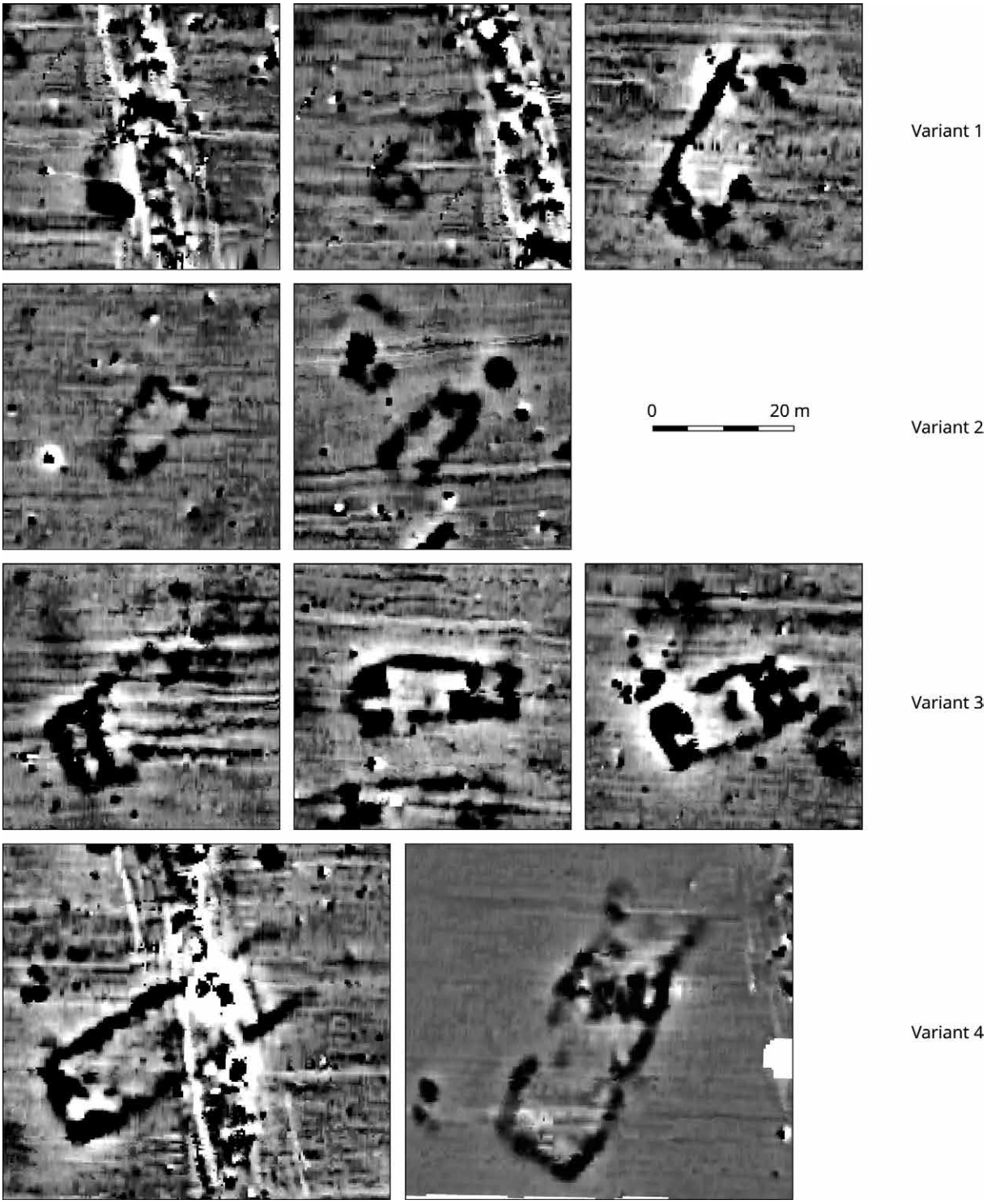


Figure 15. Variants of house floor plans visible in the plan of magnetic survey of the Cunicea 3 site (graphic R. Hofmann).

Test trenches

To verify the survey results and obtain material for relative-chronological dating, we opened test trenches in the area of two distinct anomalies. Each trench had an area of 2 × 2 m. Test trench № 1 was placed over a dugout linear feature in the

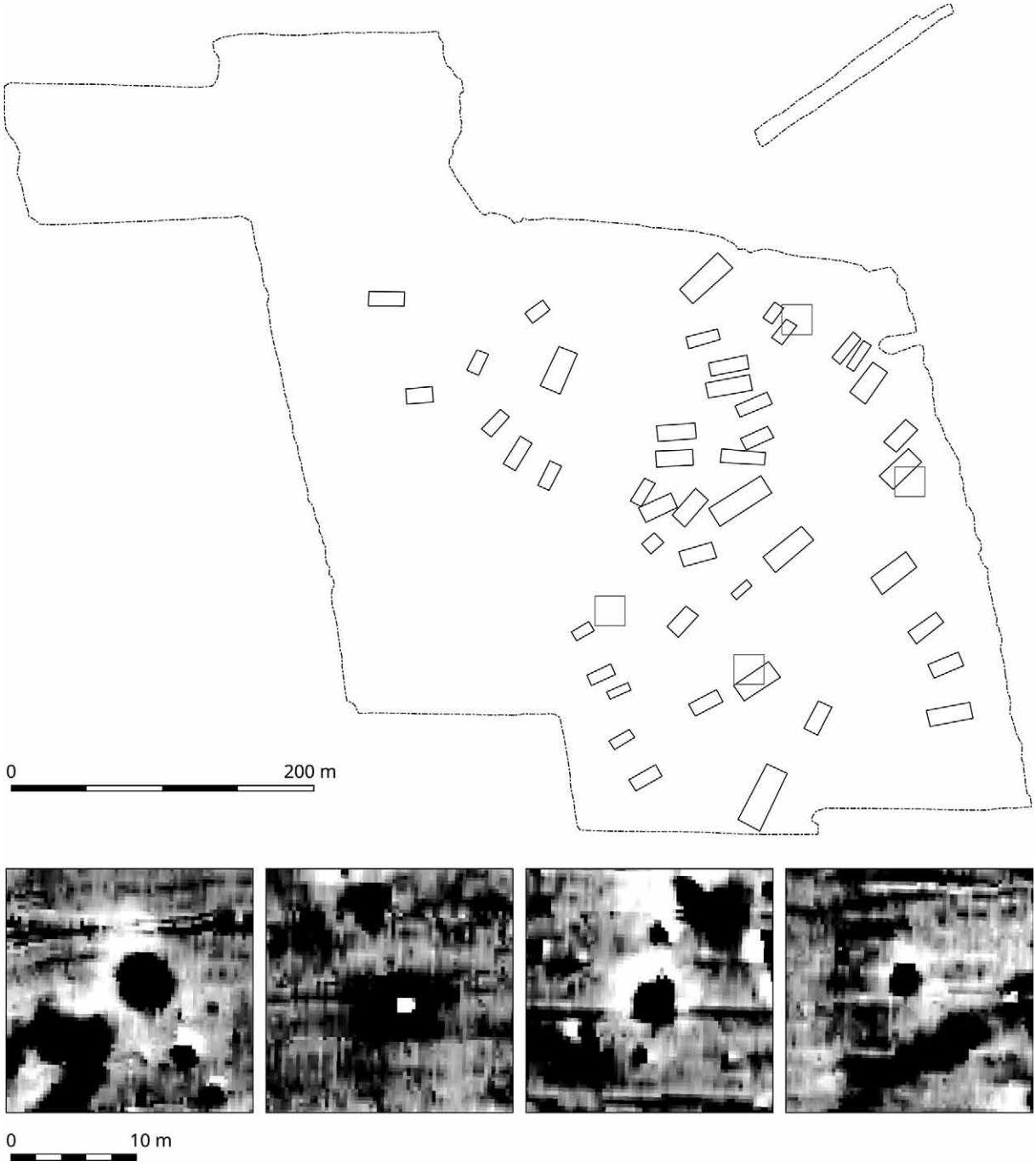


Figure 16. Potential kilns at Cunicea 3 (graphic R. Hofmann).

northwest sector of the settlement while test trench № 2 was opened over the corner of a burnt dwelling in the central part of the surveyed area.

Test trench № 1 (Fig. 17) was oriented on the southwest-northeast axis and was excavated to a depth of about 90 cm. The stratigraphy is as follows: 0–20/23 cm, arable black soil (Feature 1001); 20/23–40/46 cm, unploughed black soil (Feature 1002); 40/46–52/55 cm, dark-brown compact soil with a horizontal thin layer of small fragments of burnt clay (cultural layer); 52/55–83/85 cm (Feature 1003), compact brownish clayish soil with tiny inclusions of burnt clay (cultural layer; Feature 1004); below 83/85 cm, transition to yellow sterile soil with no archaeological remains (Feature 1005). The layer of burnt clay is slightly thicker in the NW wall of the test

trench. It was evident that the trench, all over its surface, encountered a dugout feature whose limits, unfortunately, were not captured by the survey. The thin deposition of burnt clay may represent the remains of some kind of above-ground collapsed walls; therefore, the dugout feature may be interpreted as the foundation trench for a likely eroded dwelling. The trench provided 24 ceramic fragments, 14 of which belong to the fine category, and the others to the coarse category. The decoration on the surface of fine ceramics was not preserved. The coarse ware displays admixture of crushed shards (grog). As regards the ceramic morphology, there are two relevant fragments, both made of fine ware: the rim of a semispherical bowl and the deflected neck of an amphora-like vessel with a short rim and a horizontally perforated handle (Fig. 18). Also, a flint item was discovered.

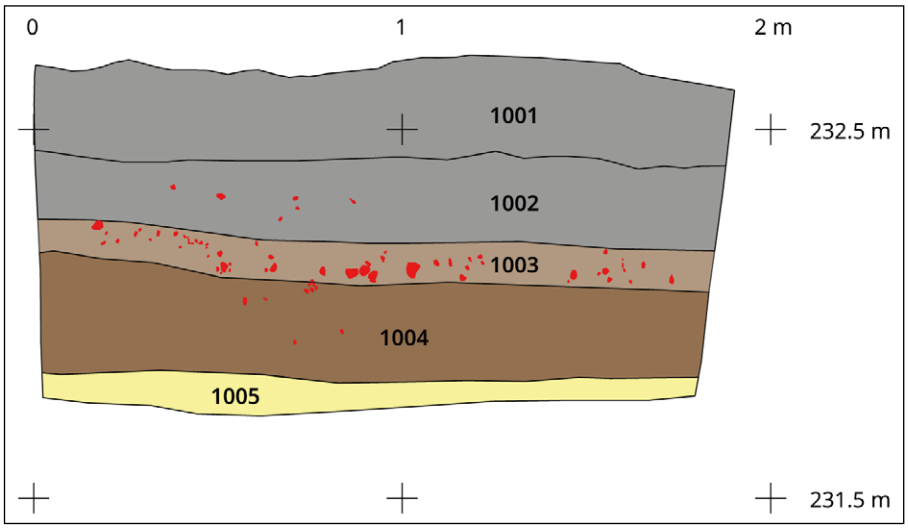


Figure 17. Test trench № 1 from Cunicea 3 site: profile and geophysical context (graphic R. Hofmann).

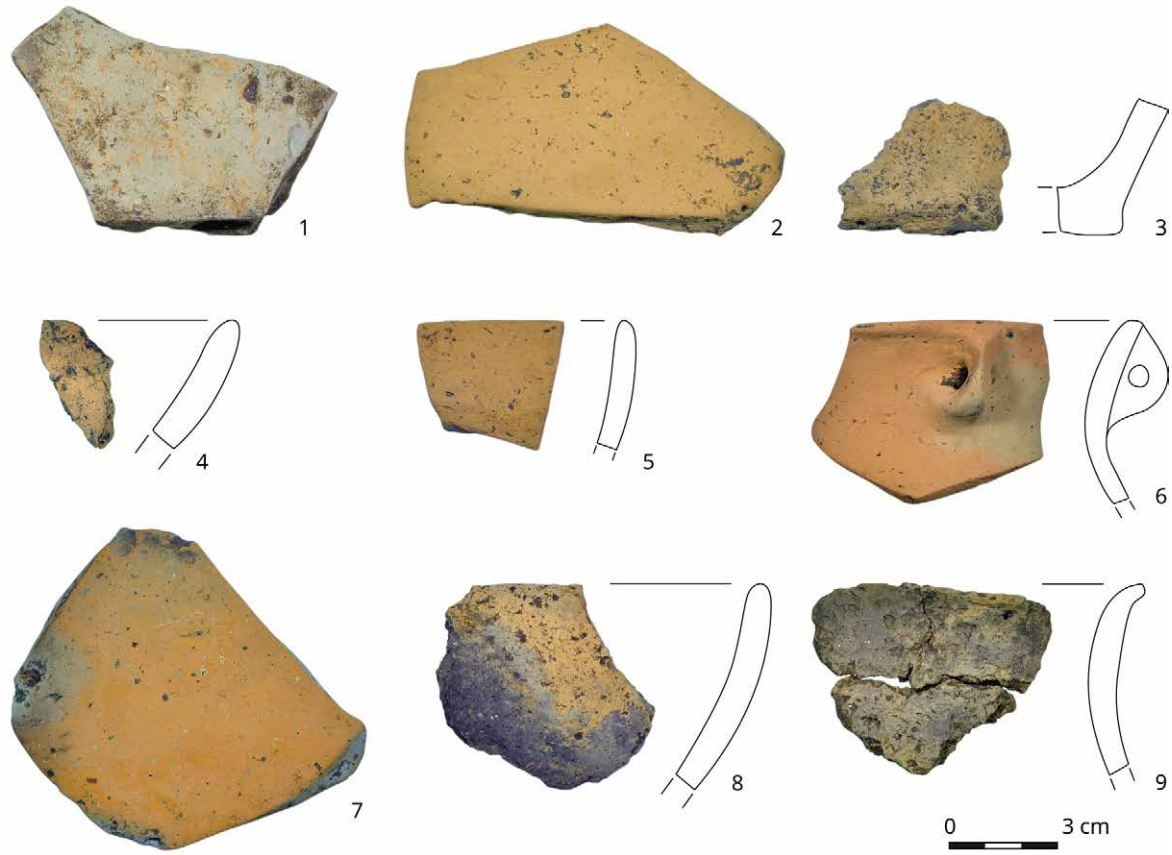


Figure 18. Pottery from Cunicea 3 site (photos S. Țerna). 1, 5–6 – test trench № 1; 2–4, 7–9 – test trench № 2.

Test trench № 2 (Fig. 19) was oriented on the north-south axis and located over the corner of a rectangular anomaly with high intensity, interpreted as a burnt dwelling. The stratigraphy is as follows: 0–25 cm, arable black soil (Feature 2001); 25–40 cm, unploughed black soil with sporadic fragments of burnt clay (Feature 2002); 40–55 cm, compact dark-brown soil with inclusions of burnt clay which, between 40 and 48 cm (Feature 2003), revealed a compact layer of burnt clay corresponding to the debris of the Copper Age dwelling (Feature 2004); below 55 cm, sterile yellow clay (Feature 2005). The compact agglomeration of daub was situated in the northwest corner of the trench (Fig. 19), in the Squares B/2 and, partially, A/2. All the clay displayed chaff admixture in its composition. The daub (weight 25.5 kg) corresponded perfectly to the south-eastern corner of the surface dwelling; most of the imprints on clay were left by twigs. The inventory was very scarce, consisting of several potshards. Most likely, the burnt clay from the test trench belonged to the wall of the construction, which fell outside. Fifteen ceramic fragments came from the survey, of which only 3 belong to the fine category. Two of them are from semispherical bowls while the third is from a vessel with a high neck and heavily deflected rim (Fig. 18).

Surface finds

Some other archaeological finds were collected from the surface of the site (Fig. 20). Thus, the fragment of a clay disc most likely belonged to a flat circular weight or spindle whorl. The Copper Age pottery, although systematically collected, is corroded and shows no remains of decoration. Most of the fine ware fragments come from semispherical bowls and vessels with deflected rims.

Botanical macro remains and animal bones

From the trenches in Cunicea 3 four botanical samples were taken and analysed (Tab. 2). Except for the smallest charcoal fragments none of these samples provided botanical macro remains.

^{14}C dating

Unfortunately, from the two test trenches no suitable sample material for ^{14}C dating was available.

Discussion

In Cunicea 3 a settlement plan was detected by archaeomagnetic surveying, which in several aspects clearly corresponds to Late Trypillia settlement layouts, but also shows some special characteristics. Corresponding layouts with interferences of spatially separated settlement groups were recently discovered in Apolianka (Rassmann *et al.* 2014) and Smaglievy Beregy (Moshuriv 2; Ohlrau and Rud 2019) in the Sinyukha River Basin. In contrast to classical ring-shaped ('circo-radial') Trypillia settlements, Ohlrau and Rud classify the spatial disposition of these sites as 'axis-symmetrical', without, however, discussing possible reasons for their formation. Investigations conducted in spring 2019 consistently attribute the dating of these sites to the time between about 3700 and 3550 BCE (Chapter 13, this work, Vol. I). Three groups of houses partly overlap in a similar way in the settlement of Kisnytsia near Kryzhopil in the Southern Bug-Dnieper Interflow area, dating to the slightly younger period between about 3600 and 3500 BCE (Chapter 14, this work, Vol. II).

In the case of the settlement of Cunicea 3, two surveys unfortunately failed to obtain suitable material for typo-chronological and radiometric dating. Both the material from the two trenches and also surface finds were very poorly preserved

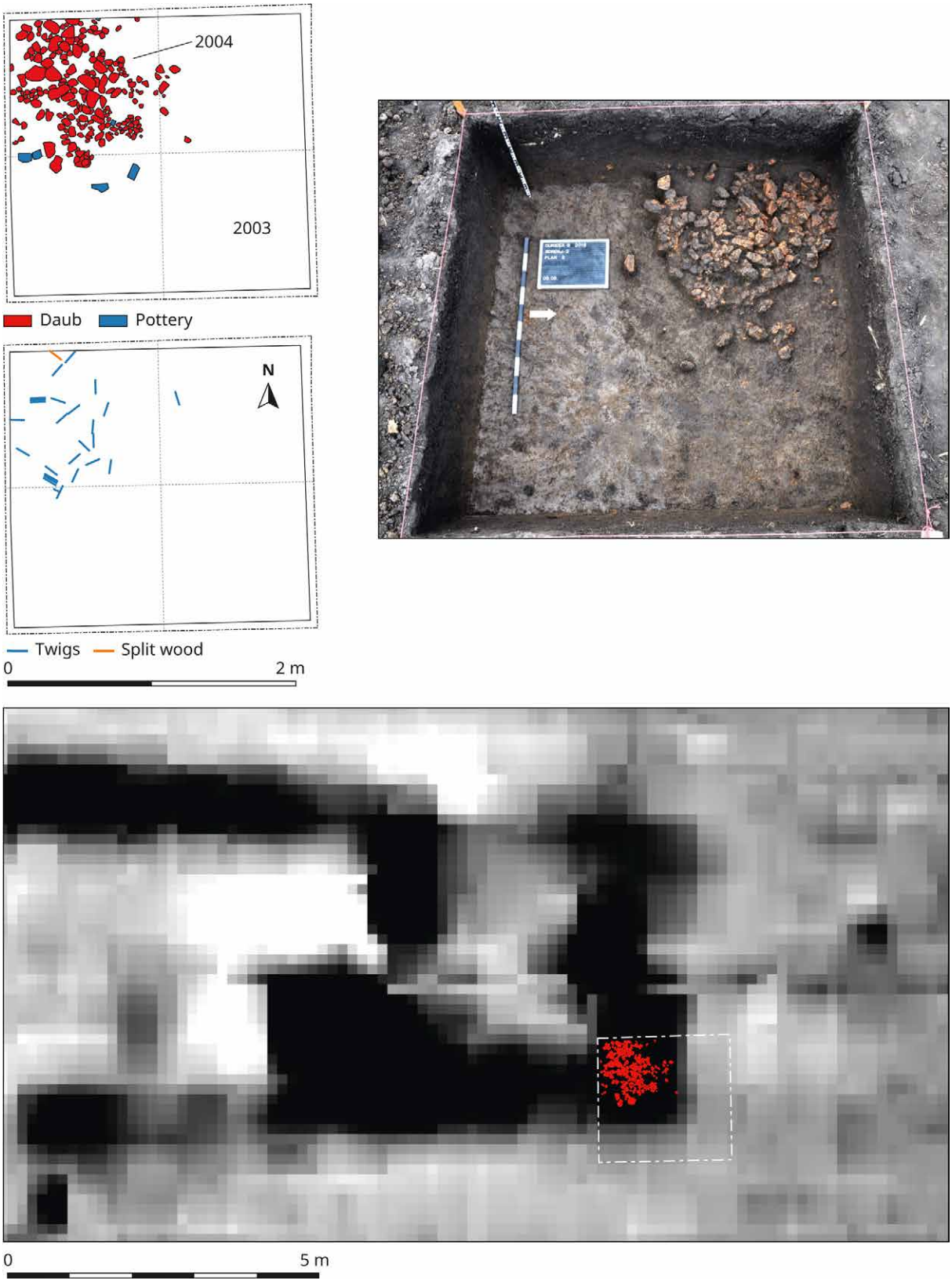


Figure 19A. Test trench № 2 from Cunicea 3 site: plan and geophysical context (graphic S. Țerna, R. Hofmann, V. Rud).

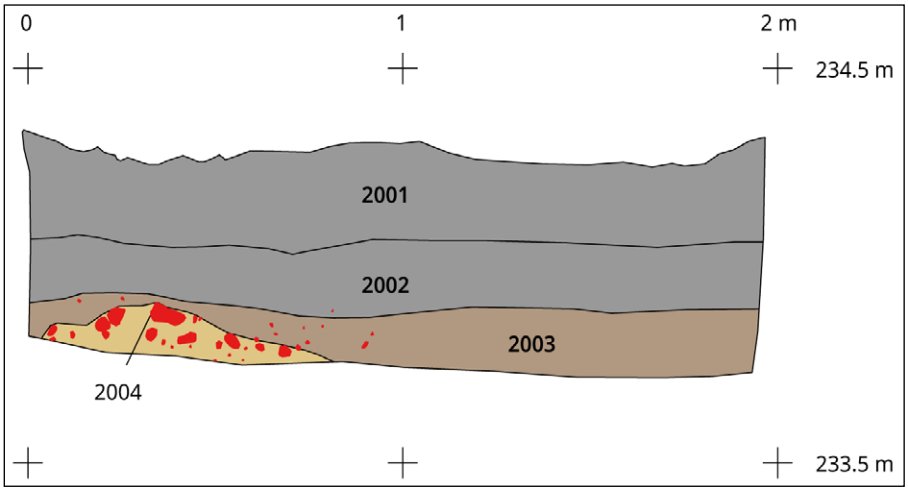


Figure 19B. Test trench № 2 from Cunicea 3 site: profile (graphic S. Țerna, R. Hofmann, V. Rud).

with no ornamentation visible. However, the predominance of semispherical bowls, vessels with deflected rim as well as the discovery of a specific discoid weight allow us to attribute the settlement firmly to the Trypillia C2 stage, perhaps of Vîhvatinți type.

Aside from these dating issues, the magnetic plan from Cunicea 3 might provide some clues for deciphering the internal chronology of such settlement layouts: decisive for the understanding of the intra-site chronology seems the fact that houses in Cunicea 3 are not oriented towards the centre as in many other Trypillia settlements, but instead show a northeast-southwest main orientation. Despite this broadly uniform orientation of houses, other characteristic elements of classical Trypillia settlements, such as an unbuilt space in the settlement centre, seem to have been maintained.

In the settlement centre, very differently oriented houses are in the immediate vicinity of each other without overlapping. In our opinion, these different orientations of neighbouring houses indicate that they are not synchronous and probably the result of a longer-term settlement process.

Based on studies of the orientation of Linear Pottery houses, a method has recently been proposed to determine the chronological sequence of houses within a settlement (Müller-Scheeßel *et al.* 2020). A phenomenon described as *'pseudoneglect'* resulted in a systematic copy error and counterclockwise deviation in attempting to copy the orientation of the neighbouring house. Over a longer period of habitation, this unconscious copy error might have led to substantial changes in the house orientation, whose precondition was the attempt to follow the social rule of uniformly oriented houses (cf. Hofmann and Müller-Scheeßel 2020).

As applied to the settlement Cunicea 3, this would indicate a beginning of settlement activities in the north (ca. 95–75°), a subsequent shift of the settlement focus to the south (ca. 75–50°) and finally a renewed shift of the focus to the north (<50°). Evidently, such a model requires independent verification. Also, other models such as the repeated occupations of the site by the same or different communities should not be excluded *a priori*. The size of the observed rotations of clearly more than 40° could indicate a repeated occupation or a very long period of settlement. In the Balkans and the Carpathian Basin they amounted between 4° and a maximum of 10° per 100 years (Hofmann and Müller-Scheeßel 2020).

Other spatial patterns observed in the Cunicea 3 settlement can only be partly matched with the proposed chronological order of houses. The supposed oldest east-west oriented houses are, with a median of 113 m², clearly larger than the more northeast-southwest (median 86 m²) or north-northwest-south-southwest (median 78 m²) oriented ones (Fig. 21). This would imply a certain downsizing of houses and possibly of households over time.

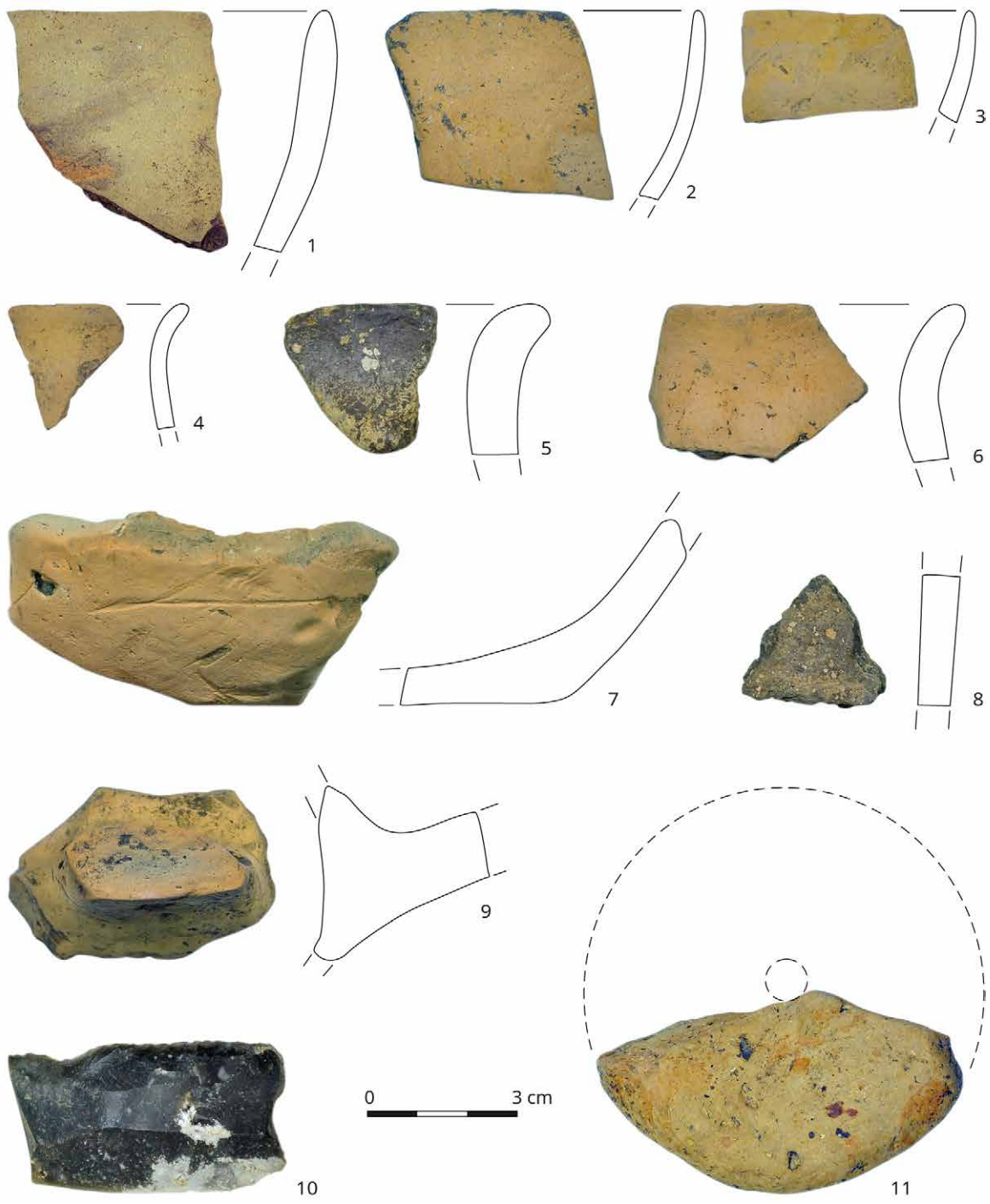


Figure 20. Pottery and small finds from the surface of Cunicea 3 site (photos S. Țerna).

Possible chronological and functional differences within the settlement might also be supported in principle by other arguments, such as the trend towards higher intensities of magnetisation (flux density) of house anomalies in the north of the settlement. For classical Trypillia-*ploschchadki* of the Southern Bug-Dnieper interfluve it can be shown how different visibility of house remains does not have to result from different degrees of erosion but rather from variations with regard to their depth and the effective quantities of deposited daub (Pickartz *et al.* 2019). The reasons for these differences are not yet fully understood, but they seem to be related

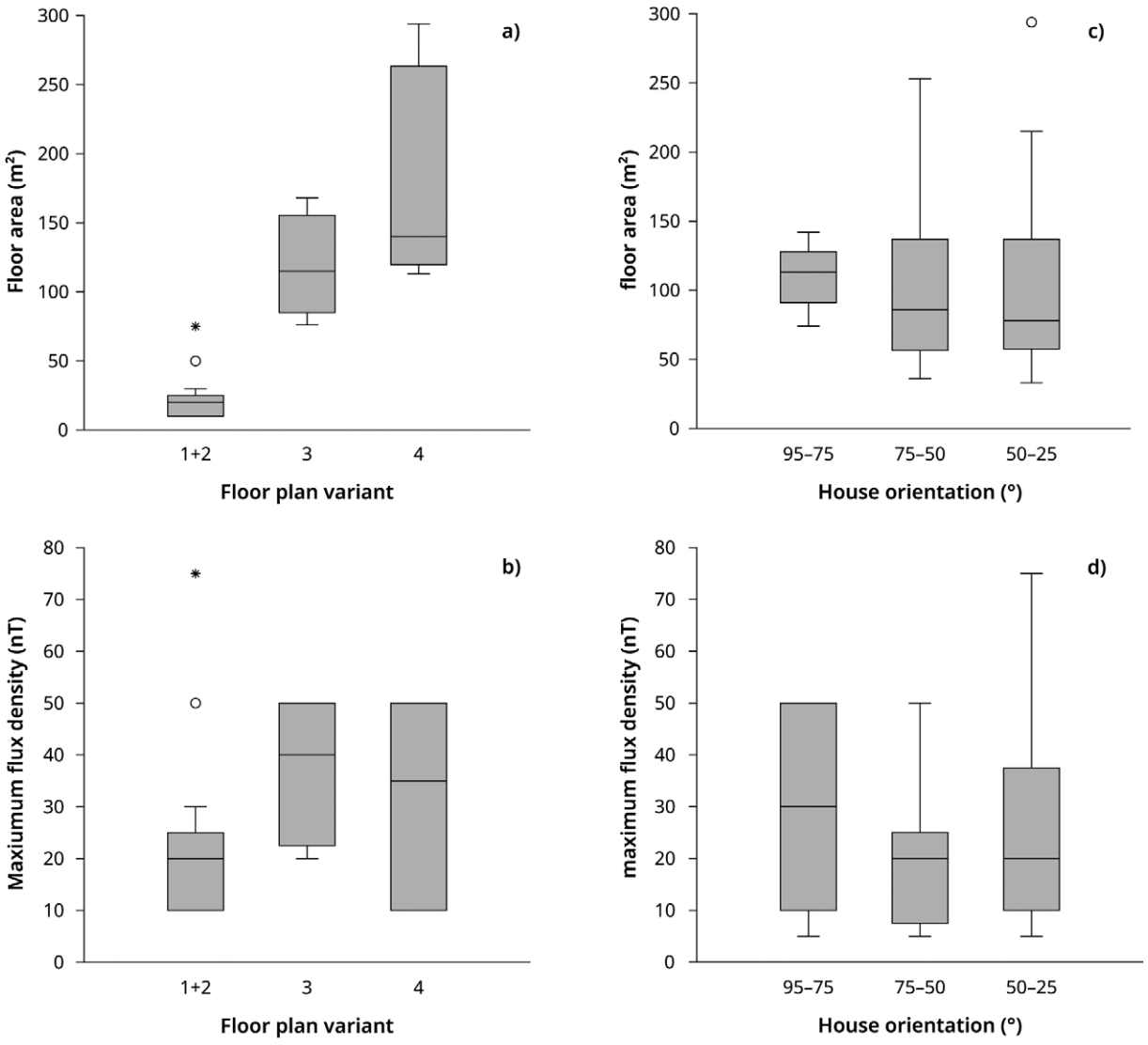


Figure 21. Cunicea 3 site, boxplot diagrams, which should show relationships between house orientation (=chronology?), intensity of magnetisation (construction and depth) and floor plan variants (function?) (graphic: R. Hofmann).

to function and design of the buildings, *e.g.* how clay-intensive the construction of the buildings was (Videiko *et al.* 2015; Diachenko 2016).

In Cunicea 3, different variants of floor plans can be distinguished between smaller and larger houses, but these are only vaguely related to the differences in the intensity of the anomalies. The subdivided ground plan variants 3 and 4, which are concentrated in the centre of the settlement, tend to have a higher maximum magnetisation than the non-subdivided ground plans of variants 1 and 2, which are located more at the edge of the settlement.

Overall, the houses detected in Cunicea 3 show a complex spatial pattern that is difficult to understand without additional investigations. It seems clear that not just a single settlement phase is represented. To explain this, different scenarios ranging from a continuous to a repeated occupation of the site may be envisioned, without it being possible to favour one model at present.

Cunicea 4

Site location and history of research

The settlement is located at ca. 3 km north of the Cunicea village, on the gentle slope of a promontory, close to a stream, a right tributary of a river located further north and flowing to the northeast, towards Dniester. The site was discovered in 2009. At that time, several ceramic fragments with typical Trypillia C2 ornamentation as well as some flint axes were collected from the surface (Topal and Țerna 2010).

Geophysical survey

The archaeomagnetic survey at Cunicea 4 covered an area of about 4.5 ha (Figs. 22–24). As a result, three types of anomalies were identified: 1. rectangular ones with high intensity (burnt dwellings, n = 5); 2. rectangular ones of partially eroded or less heavily burnt dwellings (n = 3); and 3. smaller circular/oval ones of pits that usually have low intensity (n = 4).

Due to the relatively large distances between the houses of between 20 and 45 m, it is difficult to determine to what extent the boundaries of the settlement have been identified with our survey. In the north, south and east of the prospected area are orchards with metal installations that prevented the expansion of the survey. Thus, the investigated part of the settlement is relatively small and arbitrary and the layout of the settlement is not recognisable.

On the investigated area there are: 1. a NNW-SSE running row of four houses with ENE-WSW orientation in the east; 2. a WNW-ESE running row of three NNE-SSW oriented houses west of it; 3. a single NW-SE oriented house 50 m to the south of this second row.

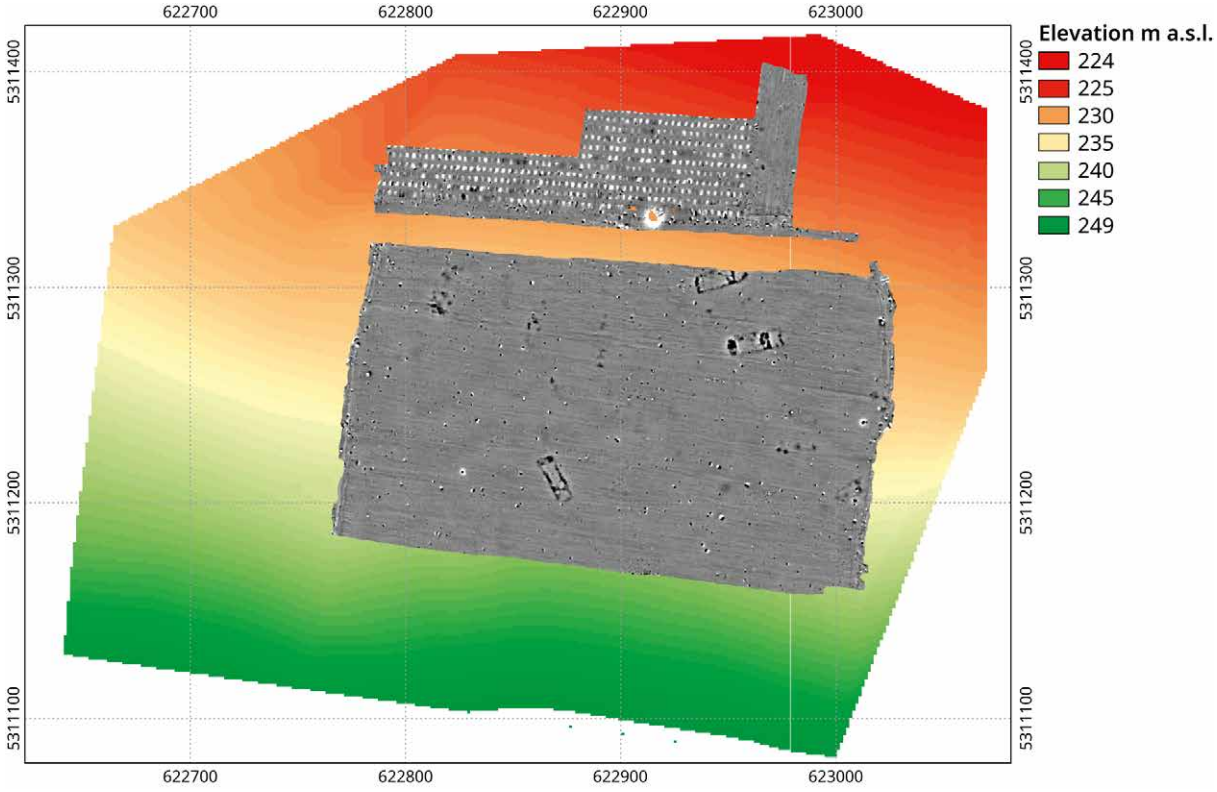


Figure 22. Geophysical plot of Cunicea 4 site (graphic R. Hofmann).

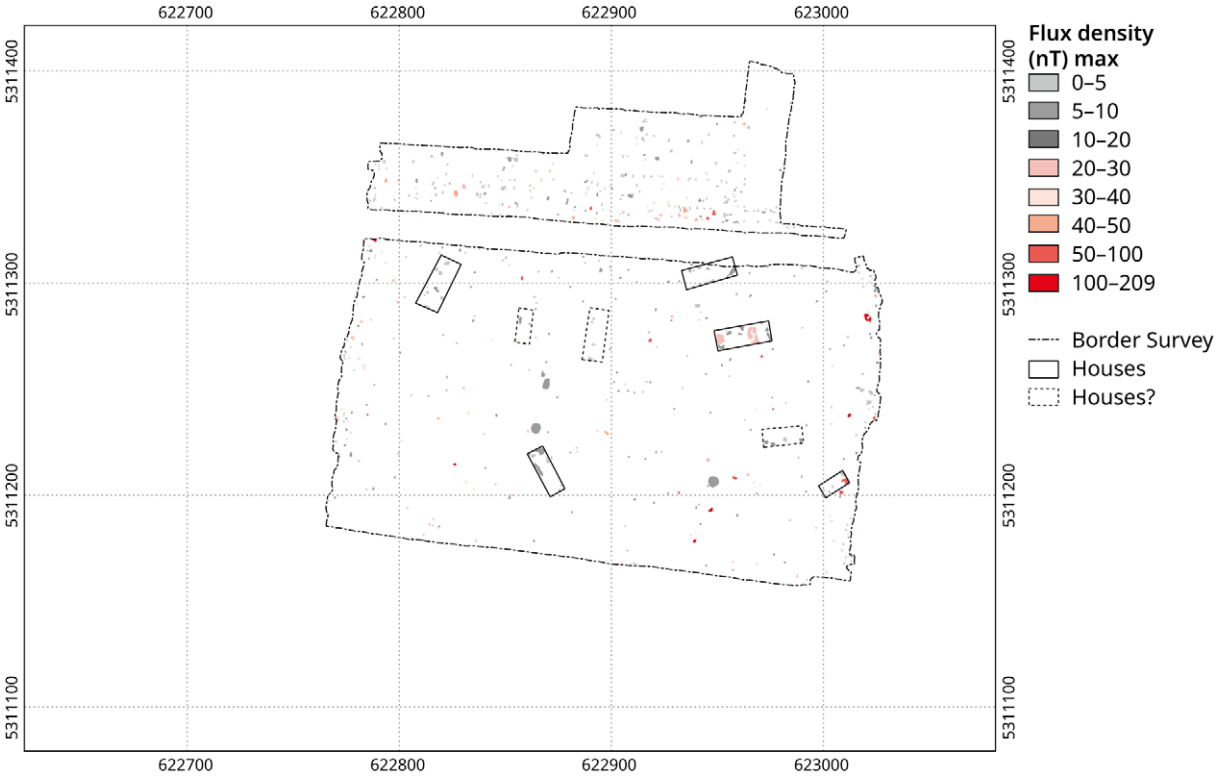


Figure 23. Classification of anomalies from the geophysical plot (graphic R. Hofmann).

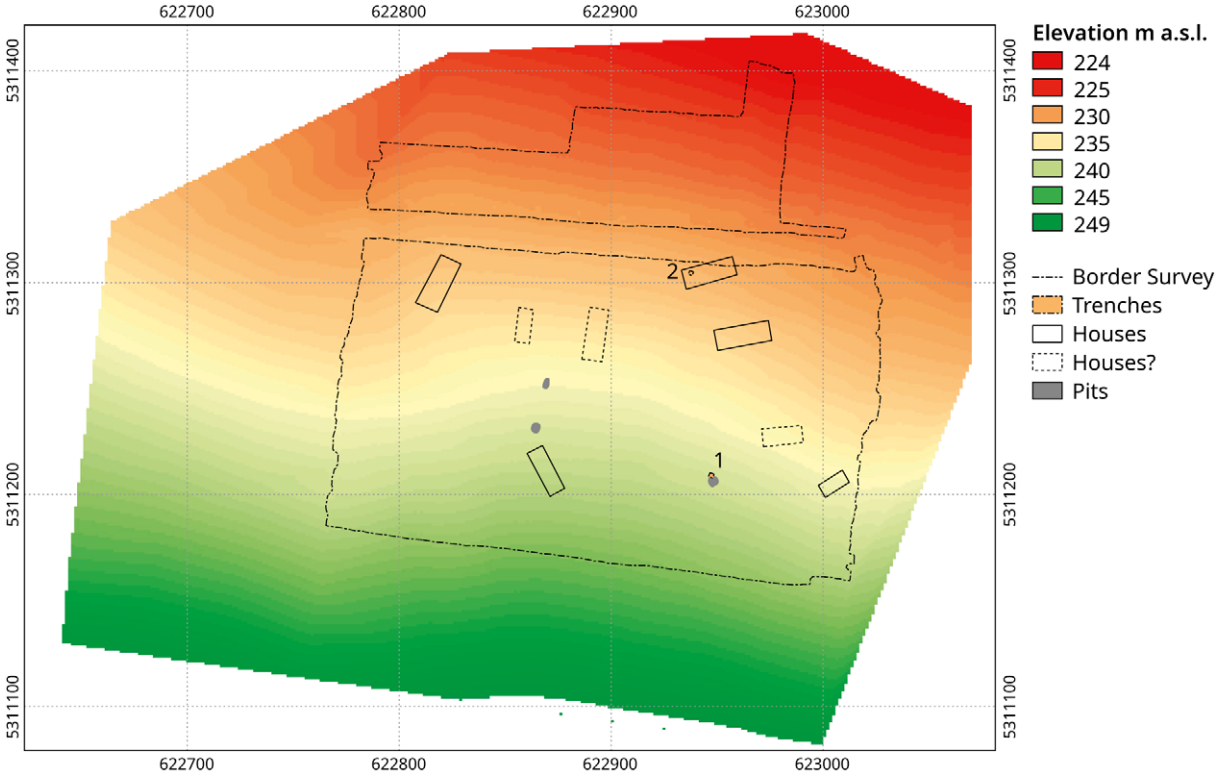


Figure 24. Interpretation of the geophysical plot (graphic R. Hofmann).

The dwellings have dimensions ranging between 3.3–9 m (width) and 7–26 m (length) and floor areas between 88 and 275 m². Their orientation varies not only by row affiliation but, to a lesser extent, also within the rows. As in Cunicea 1 and 3, the house remains show increased magnetisation only along exterior and partition walls, while the flux density inside the house corresponds to that of the surroundings. Better visible floor plans show a division into a rectangular main room and a square-shaped anteroom.

The pits are located in the area between the houses and have dimensions of about 10–25 m² (Figs. 22–24).

Test trenches

In order to verify the survey results and obtain material for the relative-chronological dating, we opened two test trenches over distinct anomalies. Trench № 1 was located over a large-sized dwelling in the northern part of the surveyed area while trench № 2 was located over one of the pits in the south of the settlement.

The first test trench measured 1 × 2 m and was located over a weak linear anomaly within the burnt house, interpreted as an interior partition wall. Indeed, the compact burnt clay from this structure started to appear at a depth of ca. 40 cm thus validating our interpretation and proving a generally good preservation of the daub debris (Fig. 25). After documenting the situation, the burnt clay was left untouched and the trench was refilled in order to protect the remains of the burnt construction.

The second test trench had an area of 2 × 2 m and was oriented on a SW-NE axis, partially covering the edge of the pit. It was taken down to a depth of 150 cm. The stratigraphy at the western wall is as follows: 0–23 cm, arable black soil (Feature 7001); 23–43 cm, black unploughed soil with sporadic fragments of burnt clay (Feature 7002); 43–80 cm, compact dark-brown soil with fragments of burnt clay and a small amount of archaeological materials (prehistoric step-surface and top of the pit refill; (Features 7003 and 7004); 80–100 cm, light-brown uncompacted soil with archaeological remains (top of the pit refill; Feature 7005); below 100 cm the transition began to yellow sterile clay (Feature 7006). In the eastern wall, where the pit had a greater depth, the stratigraphy is as follows: 0–23 cm, arable black soil; 23–43 cm, black unploughed soil with sporadic fragments of burnt clay; 43–80 cm, compact dark-brown soil with fragments of burnt clay and a small amount of archaeological materials (prehistoric step-surface and top of the pit refill); 43–80 cm, compact dark-brown soil with fragments of burnt clay and a small amount of archaeological materials (prehistoric step-surface and pit refill); 100–120/125 cm, loose light-brown soil with inclusions of ash, burnt clay and a higher quantity of archaeological remains (pit refill); 120/125–140 cm, light-brown soil with few archaeological materials (pit bottom); below 140 cm the yellow sterile soil began. The deepest sector of the pit remained unexcavated and the succession of layers described above characterise the periphery of the dugout feature (Figs. 26–27).

Finds

The trench yielded pottery (121 fragments; Fig. 28), animal bones (12 items), flint objects (45 items), six pebbles, multiple small burnt clay pieces and the conical leg of an anthropomorphic figurine with no visible decoration (Fig. 29: 4). Most of the ceramic fragments belong to the fine category (82 shards). The fine pottery is characterised by a homogeneous paste with no visible impurities or with minimal addition of crushed shards. Its surface was covered with a light-pink or yellowish engobe which served as a background for applying the main, mono- or bichrome decoration. Black colour played a major role while red was used mainly in order to fill in the space between certain stylistic elements.

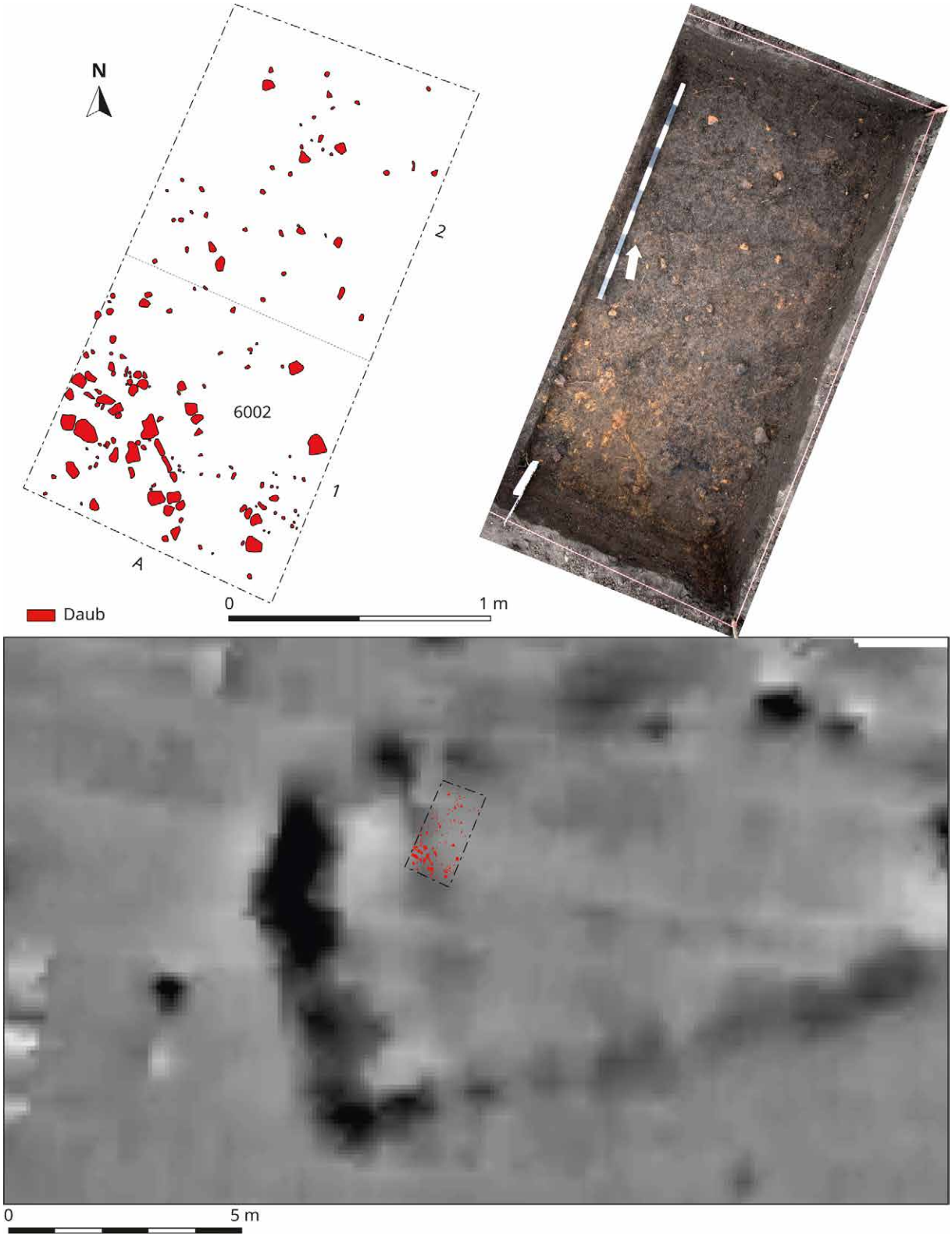


Figure 25. Test trench № 1 from Cunicea 4 site: plan (depth 40 cm) and geophysical context (graphic S. Țerna)

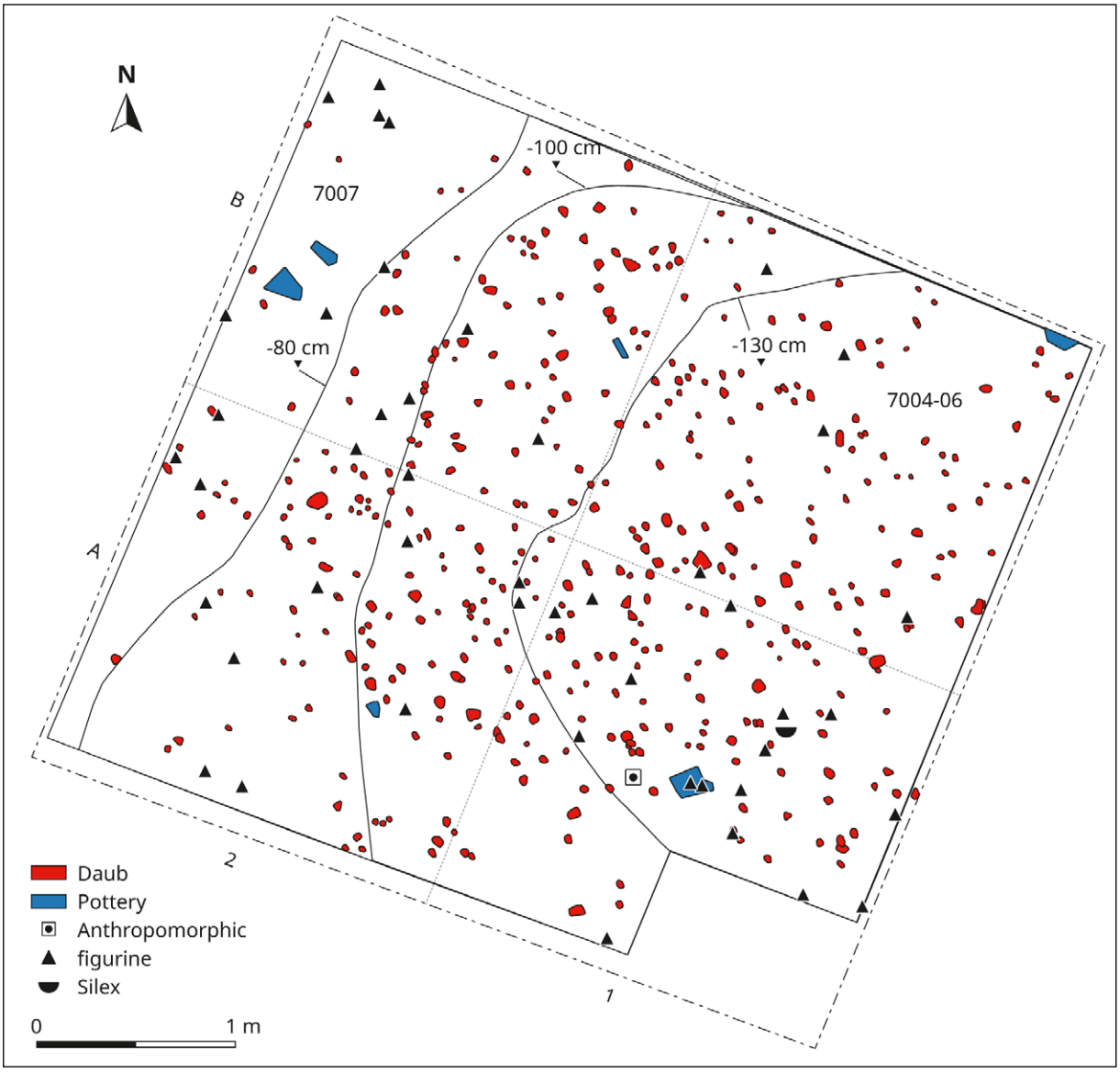


Figure 26A. Test trench № 2 from Cunicea 4 site: photo (graphic S. Țerna, V. Rud).

Morphologically, three main types can be distinguished: 1. semispherical bowls painted on both inner and outer surfaces; 2. vessels with pear-shaped body, emphasized shoulder, cylindrical neck and deflected rim; 3. vessels with likely globular body, high conical neck and thickened rim (Figs. 28–29). The painted decoration consists of horizontal, oblique and curved bands made up of 3–5 parallel lines, wavy bands, groups of vertical short lines, rows of triangles pointing down rendered below the rim, or 'net'-like pattern. On the bowls, the decoration has a metopic configuration. Coarse ware is represented by fragments of pots with admixture of crushed shards and small pebbles in the clay composition. One of the fragments comes from a vessel with likely globular body and deflected rim, decorated with small oval impressions (Fig. 28: 3). Another fragment displays 'pseudo-cord' ornamentation consisting of oblique lines intersecting each other (Fig. 29: 3). As regards the small finds, all of the flint objects represent production waste (flakes) and are made of local raw material from the Moldavian Plateau.



Figure 26B. Test trench № 2 from Cunicea 4 site: plan (graphic S. Țerna, V. Rud).

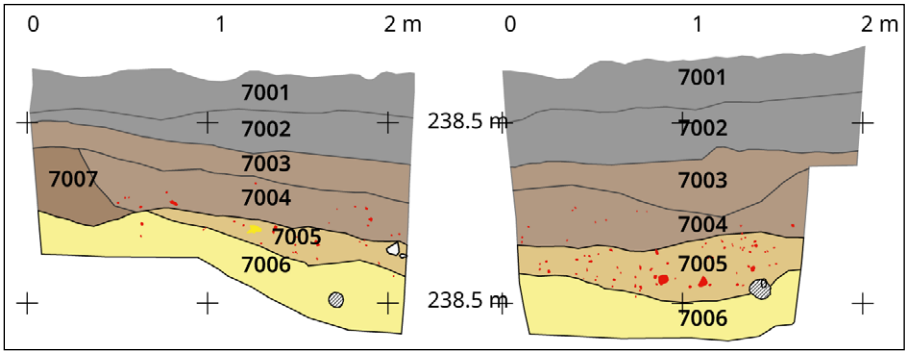


Figure 27. North and East profiles of the pit in the test trench № 2 at Cunicea 4 site (graphic R. Hofmann).

^{14}C dating

Out of three investigated samples from the Test section 1 in Cunicea 4, unfortunately only one dating was successful (Tab. 1). An indeterminable bone was dated from the deepest (7th) layer, which potentially dates the beginning of the pit filling.

The dating falls into the period between 3340 and 3100 BCE where the calibration curve is characterised by an extensive plateau (Fig. 30). Within this period, the dating cannot be more precisely defined.

Botanical macro remains and animal bones

From the trenches in Cunicea 4 two botany samples were taken and analysed (Tab. 2). Except for the smallest charcoal fragments none of these samples provided botanical macro remains.

Discussion

The painted pottery from Cunicea 4 presents an association of two decoration styles. One of them is represented by the curvilinear bands, wavy and short vertical lines, rows of triangles placed under the rim, metopes, 'net'-like pattern, while the second includes geometric motifs made up of several parallel lines of the same thickness.

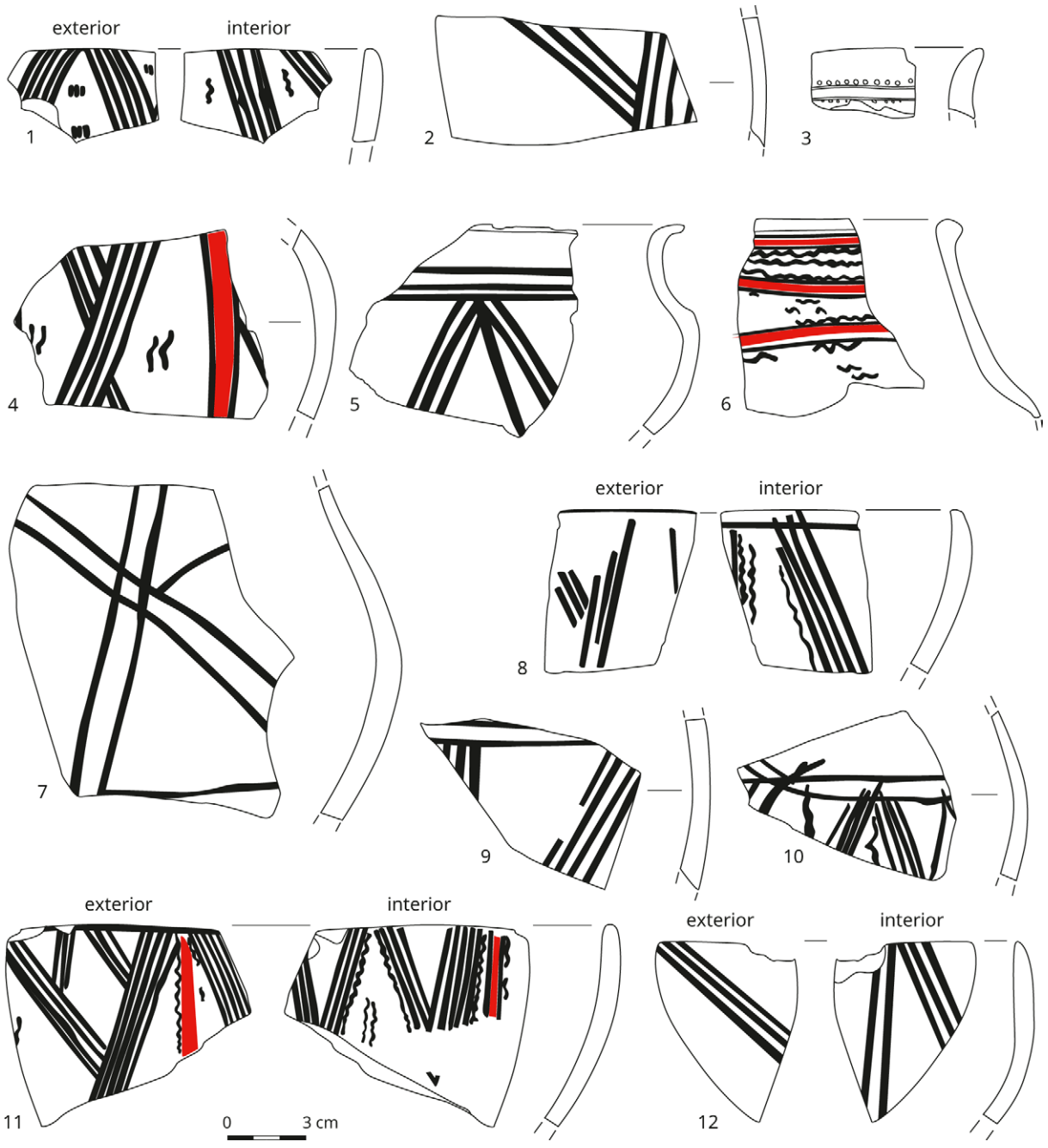


Figure 28. Pottery from the test trench № 2 at Cunicea 4 site (graphic S. Țerna).

The first tradition is specific to the Vîhvatinți, and the second to the Gordinești assemblage. Thus, the ceramic material would allow attribution of the site to the intermediary Chirileni type, defined by Bikbaev. This assumption is supported by the radiocarbon dating which indicates a slightly later date for the Cunicea 4 settlement compared to the Cunicea 1 site, thus correlating with the relative chronology, which places the Chirileni type sites after the Vîhvatinți ones.

The geophysical survey yielded several dwellings with remarkable sizes of over 200 m^2. Until now, dwellings of such dimensions have never been encountered in the – limited – excavations on Vîhvatinți or Chirileni settlements.

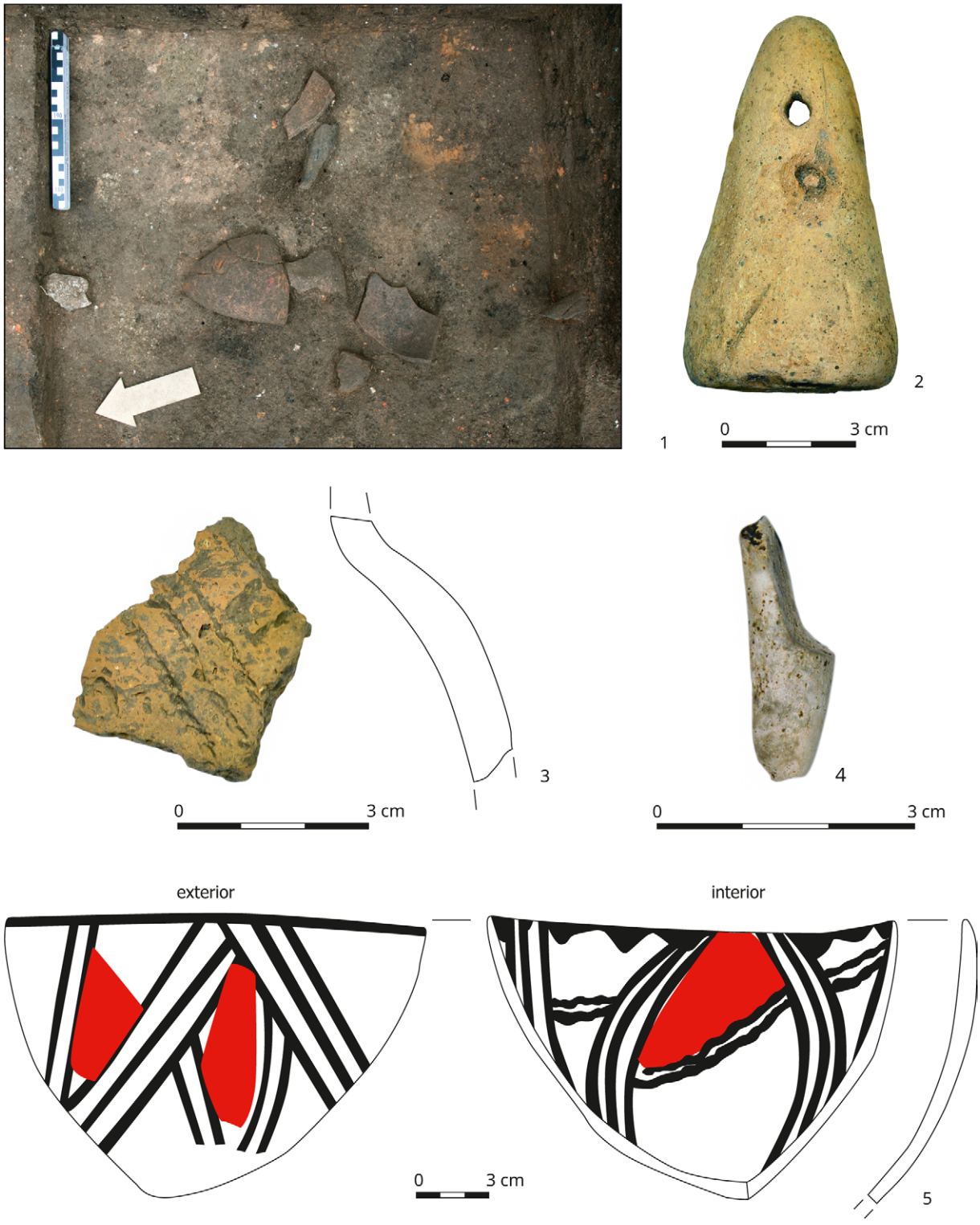


Figure 29. Finds from Cunicea 4 and Cușmirca VI sites (graphic S. Țerna). 1 – agglomeration of shards in the refill of the pit from test trench № 2 at Cunicea 4 site; 2 – clay weight from the surface of Cușmirca VI site; 3, 5 – pottery from the test trench № 2 at Cunicea 4 site; 4 – leg of anthropomorphic figurine from the test trench № 2 at Cunicea 4 site.

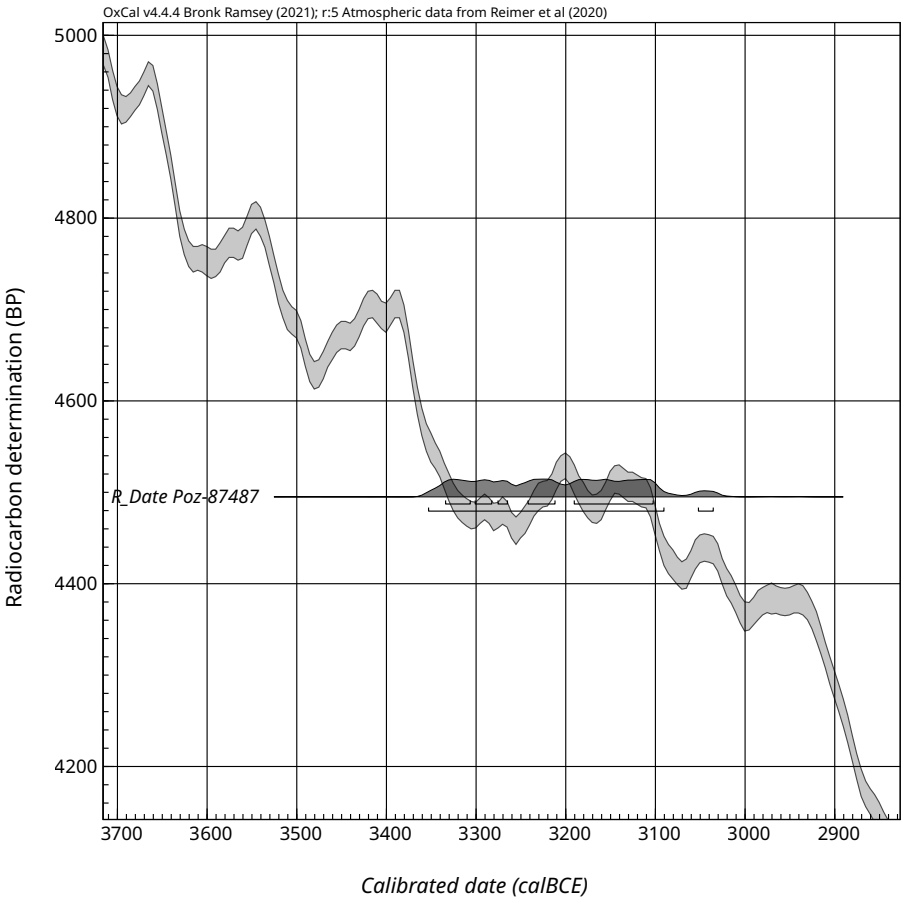


Figure 30. Cunicea 4. Calibrated ^{14}C date Poz-87487 on the calibration curve IntCal20.

Cușmirca 6

During our fieldwork, another Trypillia settlement was discovered further to the east from the Cunicea 1–2 sites, near the western margin of the Cușmirca village, close to a small stream which is a right tributary of the Cușmirca river (Fig. 1). The settlement is located on a gentle slope of the valley. Unfortunately, the exact size of the site could not be determined due to the land partition into many narrow agricultural parcels with non-homogenous crop coverage; many of them were still covered with dense vegetation and did not allow a comprehensive visual examination of the territory. However, we presume that its area does not exceed 4–5 ha.

Several agglomerations of burnt clay indicated the presence of houses. The overall amount of finds on the surface was fairly weak. Apart from some potshards, few flints and a clay pyramidal weight were collected (Fig. 29: 2). The pottery is corroded and no ornamentation was preserved; nevertheless, based on the presence of such morphological shapes as semispherical bowls and globular vessels with vertical neck and deflected rim, we can date the settlement to the Trypillia C2 stage (probably Vîhvatinți type).

Comparative analyses and discussion

The 2016 survey campaign in the Cunicea region turned out to be extremely informative, providing insights into different aspects of the stage during and after the disintegration of Trypillia agglomerated settlements in the Middle Dniester basin. These aspects are: absolute chronology, material culture development of the Trypillia C2 stage, settlement layout and house dimensions. The data obtained may

serve as a basis both for continuation of interdisciplinary research in the region as well as for calculation of various proxies for the reconstruction of socio-economic activities and structures at the disintegration stage of the Cucuteni-Trypillia culture.

Absolute and relative chronology

The two radiocarbon dates obtained from sites in the Cunicea micro-region enrich the corpus of available absolute-chronological determinations of Trypillia sites in the Prut-Dniester interfluve. They correspond well to the Trypillia C2 regional framework as was shown earlier by Diachenko and Harper (2016). Unfortunately, the attempt to obtain absolute dates from all of the investigated settlements partly failed. Indeed, although the dating of Cunicea 1 and 4 was at least partially successful, both settlements provided only one date each, whose accuracy is not secured by other dates. The dating of the settlement Cunicea 3 unfortunately failed completely.

The two successful dates seem to indicate a sequence from Cunicea 1 in the 34th century BCE to Cunicea 4 in the 33rd century BCE. Cunicea 3 shows a characteristic 'degraded' ground plan as it was present in the Sinyukha river basin since the 37th century BCE (see Chapter 13, this work, Vol. I). Also the moderate house sizes, below 100 m² in median, point to a dating of the settlement Cunicea 3 in the time before 3500 BCE (see discussion below). Thus, the most probable order of the sites explored here is: Cunicea 3 (before 3500 BCE?) – Cunicea 1 (around 3350 BCE) – Cunicea 4 (<3300 BCE).

In terms of the relative chronology of pottery styles, we see a development from monochrome dark painted Vîhvatinți ceramics in Cunicea 1 to monochrome dark and bichrome red and dark painted ceramics in Cunicea 4, which represents a combination of Vîhvatinți and Gordinești ceramics. However, the site Cunicea 1 also has a Gordinești component in at least one grave, but its chronological relation to the settlement remains unclear without dating.

The question of extramural cemeteries

In answering the question on the character of the graves in Cunicea 1 our investigations contribute only insofar as they prove a regular settlement with at least one house row for the time around 3350 BCE. Whether the buried persons were individuals buried in the context of a settlement or whether an extramural cemetery existed at the same place after the end of the settlement can only be conclusively answered by further investigations and the radiometric dating of the people from the graves. As examples from Horodiștea, Cârniceni-*Pe Coastă*, Tătărăuca Nouă XV and Pocrovca V show, settlement burials are a common practice associated with Gordinești pottery (Dergachev and Manzura 1991; Topal and Țerna 2010). Moreover, as new dating evidence from a house at the eponymous site of Gordinești shows (Rybicka 2019), there is no fundamental contradiction in absolute-chronological terms: this house dates with the highest probability between 3320 and 3240 BCE and is thus only slightly younger than the settlement remains of Cunicea 1.

Settlement layout

The Trypillia settlements of the Cunicea region have been investigated archaeomagnetically to very different degrees. The plans achieved can therefore only be compared to a limited extent. For the settlements Cunicea 1 and 4 the total size is unknown. The plans only show rows of houses whose general concept may not yet be visible due to the relatively small-sized survey area. In contrast, we surveyed the settlement of Cunicea 3 probably almost completely. In the case of

Cunicea 2 no anomalies could be detected at all, although surface finds indicate the existence of a settlement.

The settlement plan of Cunicea 3 shows a so-called 'degraded' layout, in which only some elements like curved house rows of houses evoke ring-shaped Trypillia settlements. However, the formal relationship is attested by very similar ground-plans of the late Trypillia period in the Sinyukha river basin (Apolianka: Rassmann *et al.* 2014; Rohy and Smagllievy Berehy: Ohlrau 2020a, 244–246) and the Southern Bug Dnieper interfluve (Kisnytsia and Krynychky: Chapter 14, this work, Vol. II). However, in contrast to these settlements, the houses in Cunicea 3 are not oriented towards the settlement centre, but instead show a uniform NE-SW main orientation. In this aspect, the degradation of the ring-shaped settlement concept seems more advanced in Cunicea 3.

Spatial analyses provide evidence that the settlement plan is the result of repeated occupations of the site. Therefore, it is reasonable to assume significantly smaller communities than the relatively large settlement area seems to imply at first. As archaeomagetic surveys in Răzălăi VIII (Țerna *et al.* 2020) and Apolianka (Rassmann *et al.* 2014) show, these ground plans might not be the outcome of joint settlement planning but rather the result of both decentralised decision-making and repeated occupations.

House sizes and architecture

In Trypillian contexts, house sizes have already been considered, as under favourable circumstances they can reveal something about household sizes, inheritance rules, mobility behaviour or social differences within a society (*e.g.* Porčić 2010; Porčić 2011; Porčić 2012; Porčić 2018; Wilk 1983). Furthermore, they provide the basis for estimating local population sizes and can also be compared with each other with relatively little effort (*e.g.* Rassmann *et al.* 2014; Ohlrau 2015; Müller *et al.* 2016; Diachenko 2016; Hofmann *et al.* 2016; Ohlrau 2020b; Chapter 14, this work, Vol. II). In Trypillia, investigations of house sizes have so far been carried out mainly at the analytical level of individual settlements and have only recently been systematically presented and interpreted on a macro-regional and diachronic level (Hofmann *et al.* 2024). We therefore know relatively little about how house sizes change in socio-economic and historical processes and which factors are decisive for this (cf. Müller 2013).

In Trypillian settlements it was possible to identify a special category of particularly large and prominently placed so-called mega-structures as communal buildings for integrative activities and decision-making and to differentiate them functionally from normal residential buildings (*e.g.* Chapman *et al.* 2016; Burdo and Videiko 2016; Hofmann *et al.* 2019; Ohlrau 2020a; Pickartz *et al.* 2019). In the case of residential buildings, a considerable variability of house sizes was recorded both within settlements (Chapters 16 and 17, this work, Vol. II) and in a diachronic perspective at regional level (*e.g.* Ohlrau 2015; Rassmann *et al.* 2016; Hofmann *et al.* 2024). This variability at site level can potentially be interpreted in terms of social and functional differences (Chapter 16, this work, Vol. II; Hofmann *et al.* 2024).

In both regions, in the Southern Bug-Dnieper interfluve and also between Prut and Dnieper, we can see a clear trend towards larger houses in late Trypillian settlements after the disintegration of agglomerated (mega-)sites: while house sizes in classical ring-shaped settlements of the Trypillia B2 and C1 periods are usually clearly smaller than 100 m² (*e.g.* Maidanetske, 72 m²; Talianki, 70 m²; Petreni, 54 m²; Ohlrau 2015; Rassmann *et al.* 2016), the average house size (median) in post-mega-site-age settlements is usually much higher and often amounts to close to 200 m² (*e.g.* Apolianka, 197 m²; Cunicea 1, 166 m²; Cunicea 4, 205 m²). Along with the disintegration of large agglomerated Trypillia settlements, there is a clear trend towards larger houses, which can also be demonstrated in settlements of the Cunicea micro-region.

If, in turn, one accepts house sizes as an indicator for the dating of a settlement, this would place Cunicea 3 in the vicinity of typical ring-shaped Trypillia settlements of the periods Trypillia B1–2 to C1. Thus, Cunicea 3 potentially represents the oldest of the surveyed settlements, which, due to the size of the houses and the formal proximity of its layout to other late Trypillia settlements east of the Dniester, might date back to the time before the middle of the 4th millennium BCE.

It is symptomatic that in all the settlements of the late Trypillia period that have been archaeomagnetically surveyed to date, mega-structures are missing. As communal buildings these provided the stage for integrative activities and thus contributed at different levels to the social cohesion within large communities. If the criteria defined elsewhere for identifying such buildings are applied (Hofmann *et al.* 2019), their absence is also evident for the investigated settlements of the Cunicea micro-region.

It is difficult to assess exactly which social or economic alterations might have led to the doubling of house sizes. Although the houses from the Cunicea micro-region no longer represent classic Trypillia buildings with elevated platforms but more probably ground-level buildings, there seems to be a continuation of the internal subdivision into a main room and an anteroom. In this respect, no fundamental structural changes are visible in comparison to earlier houses, which might indicate for example the separation of different nuclear families or the integration of new economic functions such as the stabling of livestock. Other possible reasons for larger houses, such as a trend towards greater sedentariness or the establishment of matrilineal inheritance rules, do not seem to apply: usually in the late Trypillia period an opposite trend towards a more mobile pastoral economy and more patriarchal social structures is assumed (Passek 1949, 20; Chernysh 1959; Marchevici 1981, 150f.; Renfrew 2002).

Compared to earlier ring-shaped Trypillia settlements, different transformations are reflected in the investigated settlements: 1. The smaller settlement sizes indicate considerably smaller communities. 2. 'Degraded' settlement layouts indicate a lower degree of settlement organisation. 3. The lack of mega-structures indicates a lower degree of social integration. We believe that under such conditions individual households had increased autonomy and that this could explain the increase in household size. For example, the combination of a higher demand for labour (resulting from the need for diversification) and the desire to minimise risk (risk management) may have led to greater integration of several generations in one household. However, in order to confirm the proposed trend, a drastic increase in the number of inhabitants of late Trypillia-age houses would first have to be proven by independent methods.

Concluding remarks

The investigations undertaken in the Cunicea microzone contribute to our knowledge about the Late Trypillia of Middle Dniester region, which was densely inhabited in the second half of the 4th millennium BCE (Passek 1955; Marchevici 1955; Marchevici 1973; Țerna *et al.* 2014). As regards the spatial layout and dimensions of sites, our investigations illustrate well the different stages of the disintegration of socio-economic life around and after 3500 BCE, when settlements became much smaller than before and their structure became dispersed, with the houses arranged in rows and small groups. From a demographical point of view, the population size decreases drastically, affecting the size of social units; therefore, the mechanisms of decision-making and maintaining social cohesion go through obvious changes. This is illustrated by the growth of house sizes while settlement areas reduce in size. If compared to the ring-shaped settlements from the first half of the 4th millennium BCE, the Trypillia C2 dwellings from Cunicea 3 and, especially,

Cunicea 4, act like veritable 'longhouses' since, as pointed out by Diachenko (2019, 236), 'social transformations were framed by the refocusing of labour from large groups to the scale of families and concentration of products at the same level'. This process provoked an optimisation of settlement systems resulting in the emergence of settlement clusters consisting of several small villages.

For the Trypillia C2 stage in the Prut-Dniester interfluve, such elongated houses have been identified for the first time at Cunicea and they seem to fit the same scenario as in the Uman region in Ukraine, where radial mega-sites were replaced by smaller settlements with larger house areas (Apolianka: cf. Rassmann *et al.* 2016). At the same time it is noteworthy that, for example, large-scale excavations by Marchevici (1981) at Brînzeni III, when 37 houses were investigated, did not produce a single elongated dwelling like the ones from Cunicea. Obviously, there is a certain diversity in the Trypillia C2 settlement patterns and size-ranks of houses. Understanding the details and reasons for such diversity are a task for future research.

Acknowledgements

We would in particular like to thank Gesa Salefsky, Wiebke Mainusch, Matthias Fischer, Marcel Rodens and Lennart Brandtstätter for their dedicated work not only in Cunicea but also during our further trip to the west of Moldova and Serbia. Furthermore, we would like to thank Aleksandar Medović, Novi Sad, for generously taking on the flotation of soil samples for the botanical analysis. Thank you also to Wiebke Kirleis and her team in Kiel who carried out further processing of the botanical samples. We would also like to thank Cheryl Makarewicz for the determination of bone for ^{14}C dating. Our thanks go as well to Denis Topal (National Museum of History of Moldova, Chișinău) for providing us the photo of the *in situ* finds from the first grave at Cunicea 1. We are also grateful for the warm welcome that the Pridorojnov family provided us as our hosts in Cunicea.

The fieldwork was possible thanks to available postdoctoral funds of the Graduate School 'Human Development in Landscapes'. Due to thematic interlinking, the data analysis and writing of this paper was partly carried out within the framework of the subproject D1 'Population agglomerations at Trypillia-Cucuteni mega-sites' which is part of the Kiel Collaborative Research Centre 1266, 'Scales of Transformation – Human-Environmental Interaction in Prehistoric and Archaic Societies' (German Research Foundation – Project number 290391021 – SFB 1266).

References

Bikbaev 1994: Бикбаев, В.М., 1994. Предгординештские памятники типа Кирилень в Северной Молдове. *In*: Е.В. Яровой, ed. Древнейшие общности земледельцев и скотоводов Северного причерноморья (*V* тыс. до н.э. – *V в. н.э)*. Тирасполь: ТДК, 64–69.

Burdo, N. and Videiko, M., 2016. Nebelivka: From Magnetic Prospection to New Features of Mega-Sites. *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE.* Themes in Contemporary Archaeology 2. London, New York: Routledge, 95–116. Available from: DOI: 10.4324/9781315630731

Chapman, J., Gaydarska, B. and Hale, D., 2016. Nebelivka: Assembly Houses, Ditches, and Social Structure. *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE.* Themes in Contemporary Archaeology 2. London, New York: Routledge, 117–131. Available from: DOI: 10.4324/9781315630731

Chernysh 1959: Черниш, К.К., 1959. Раннотрипільське поселення Ленківці на середньому Дністрі. Київ: Вид-во Академії наук Української РСР.

Dergachev 1980: Дергачев, В.А., 1980. Памятники позднего энеолита (опыт систематизации). Кишинев: Штиинца.

Dergachev and Manzura 1991: Дергачев, В.А. and Манзура, И.В., 1991. Погребальные комплексы позднего Триполья. Кишинев: Штиинца.

Diachenko, A., 2016. Demography Reloaded. *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE.* Themes in Contemporary Archaeology 2. London, New York: Routledge, 181–193. Available from: DOI:10.4324/9781315630731

Diachenko, A., 2019. The Late Tripolye: Spatio-demographic frames for culture change. *In*: A. Diachenko, M. Rybicka, D. Król and G. Sîrbu, eds. *Dynamics of Social Changes from the Eastern Carpathians to the Dnieper in the 4th – beginning of 3rd Millennium BC (preliminary study)*. Rzeszów: Wydawnictwo Uniwersytetu Rzeszowskiego, 231–242.

Diachenko, A. and Harper, T.K., 2016. The absolute chronology of Late Tripolye sites: a regional approach. *Sprawozdania Archeologiczne*, 68, 81–105. Available from: https://rcin.org.pl/dlibra/publication/80409

Hofmann, R. and Müller-Scheeßel, N., 2020. Orientation of Neolithic dwellings in Central and Southeast Europe: Common denominator between the Vinča and Linearbandkeramik worlds. *Quaternary International*, 560–561, 142–153. Available from: DOI:10.1016/j.quaint.2020.05.006

Hofmann, R., Țerna, S., Ursu, C.-E., Brandtstätter, L., Tiede, H., Mainusch, W. and Authenrieth, S., 2016. Spatial organization and population size of small Cucuteni-Tripolye settlements: Results of geomagnetic surveys in Baia and Adâncata, Suceava County, Bucovina, Eastern Romania. *Journal of Neolithic Archaeology*, 18, 157–189. Available from: DOI:10.12766/jna.2016.4

Hofmann, R., Müller, J., Shatilo, L., Videiko, M., Ohlrau, R., Rud, V., Burdo, N., Dal Corso, M., Dreibrodt, S. and Kirleis, W., 2019. Governing Tripolye: Integrative architecture in Tripolye settlements. *PLoS ONE*, 14 (9), e0222243. Available from: DOI:10.1371/journal.pone.0222243

Hofmann, R., Müller-Scheeßel, N. and Müller, J., 2024. Trypillia mega-sites: a social levelling concept? *Antiquity*, 98 (398), 380–400. Available from: DOI:10.15184/aqy.2024.18

Manzura, I., 1994. Manifestări culturale în perioada de tranziție. *Thraco-Dacica*, XV (1–2), 103–119.

Manzura 2018: Манзура, И.В., 2018. Расписная керамика позднего энеолита на поселении Орловка-Картал на Нижнем Дунае. *In*: В.С. Синика and Р.А. Рабинович, eds. Древности. Исследования. Проблемы. Сборник статей в честь 70-летия Н.П. Тельнова / *ANTIQUITIES. STUDIES. ISSUES. Essays in honour of Nicolai Telnov on the occasion of his 70th birthday.* Кишинев-Тирасполь: Stratum Library, 35–48.

Marchevici 1955: Маркевич, В.И., 1955. Археологические памятники в бассейне нижнего течения реки Черна. Известия Молдавского Филиала Академии Наук СССР, 5 (25), 131–144.

Marchevici 1973: Маркевич, В.И., 1973. Памятники эпох неолита и энеолита. Археологическая карта Молдавской ССР 2. Кишинев: Штиинца.

Marchevici 1981: Маркевич, В.И., 1981. *Позднетрипольские племена северной Молдавии*. Кишинев: Штиинца.

Müller, J., 2013. Mesolithisch – neolithisch: Zur Entwicklung von Hütten und Häusern im südlichen Skandinavien und nördlichen Mitteleuropa. *Offa*, 69/70 (2012/2013), 249–264.

Müller, J., Hofmann, R., Brandtstätter, L., Ohlrau, R. and Videiko, M., 2016. Chronology and Demography: How Many People Lived in a Mega-Site? *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE.* Themes in Contemporary Archaeology 2. London, New York: Routledge, 133–170. Available from: DOI:10.4324/9781315630731

Müller-Scheeßel, N., Müller, J., Cheben, I., Mainusch, W., Rassmann, K., Rabbel, W., Corradini, E. and Furholt, M., 2020. A new approach to the temporal significance of house orientations in European Early Neolithic settlements. *PLoS ONE*, 15 (1), e0226082. Available from: DOI:10.1371/journal.pone.0226082

Ohlrau, R., 2015. Trypillia Großsiedlungen: Geomagnetische Prospektion und architektursoziologische Perspektiven. *Journal of Neolithic Archaeology*, 17, 17–100. Available from: DOI:10.12766/jna.2015.3

Ohlrau, R., 2020a. *Maidanets'ke: Development and decline of a Trypillia mega-site in Central Ukraine*. Scales of Transformation in Prehistoric and Archaic Societies 7. Leiden: Sidestone Press. Available from: DOI:10.59641/h0912kt

Ohlrau, R., 2020b. Modelling Trypillia 'mega-site' populations. *In*: M. Dębiec and T. Saile, eds. *A Planitiebus usque ad montes: Studia Archaeologica Andreae Pelisiak vitae anno sexagesimo quinto oblata*. Rzeszów: Zimowit, 399–413.

Ohlrau, R. and Rud, V., 2019. Testing Trypillian site development via geomagnetic survey – New "mega-structures" and plans of smaller sites. *In*: D. Mischka, C. Mischka and C. Preoteasa, eds. *Beyond Excavation. Geophysics, Aerial Photography and the Use of Drones in Eastern and Southeastern European Archaeology. Proceedings of the International Colloquium, 5-8 December 2016, Piatra-Neamț, Romania*. Bibliotheca Memoriae Antiquitatis 40; Erlanger Studien zur Prähistorischen Archäologie 3. Piatra-Neamț: Editura "Constantin Matasă", 87–113.

Passek 1949: Пассек, Т.С., 1949. Периодизация трипольских поселений *(III–II* тыс. до н.э*.)*. Материалы и исследования по археологии СССР (МИА) 10. Москва, Ленинград: Издательство Академии наук СССР.

Passek 1955: Пассек, Т.С., 1955. Новые данные о позднетрипольских поселениях на Днестре. Известия Молдавского Филиала Академии Наук СССР, 5 (25), 15–29.

Pickartz, N., Hofmann, R., Dreibrodt, S., Rassmann, K., Shatilo, L., Ohlrau, R., Wilken, D. and Rabbel, W., 2019. Deciphering archeological contexts from the magnetic map: Determination of daub distribution and mass of Chalcolithic house remains. *The Holocene*, 29 (10), 1637–1652. Available from: DOI:10.1177/0959683619857238

Popovici, S. and Ceban, I., 2014a. Cercetările de salvare în situl Cunicea – Prișanscaia Gora din 2012. Rezultate preliminare. *Arheologia preventivă* în *Republica Moldova*, I (1–2), 29–34.

Popovici, S. and Ceban, I., 2014b. Rezultatele cercetărilor arheologice din situl Tripolie CII de la Cunicea – Prișanskaia Gora. *Arheologia Moldovei*, XXXVII, 205–217.

Porčić, M., 2010. House Floor Area as a Correlate of Marital Residence Pattern: A Logistic Regression Approach. *Cross-Cultural Research*, 44 (4), 405–424. Available from: DOI:10.1177/1069397110378839

Porčić, M., 2011. An exercise in archaeological demography: estimating the population size of Late Neolithic settlements in the Central Balkans. *Documenta Praehistorica*, 38, 323–332. Available from: DOI:10.4312/dp.38.25

Porčić, M., 2012. Effects of Residential Mobility on the Ratio of Average House Floor Area to Average Household Size: Implications for Demographic Reconstructions in Archaeology. *Cross-Cultural Research*, 46 (1), 72–86. Available from: DOI:10.1177/1069397111423889

Porčić, M., 2018. Evaluating Social Complexity and Inequality in the Balkans between 6500 and 4200 BC. *Journal of Archaeological Research*, 27 (2019), 335–390. Available from: DOI:10.1007/s10814-018-9126-6

Rassmann, K., Ohlrau, R., Hofmann, R., Mischka, C., Burdo, N., Videjko, M.Y. and Müller, J., 2014. High precision Tripolye settlement plans, demographic estimations and settlement organization. *Journal of Neolithic Archaeology*, 16, 96–134. Available from: DOI:10.12766/jna.2014.3

Rassmann, K., Korvin-Piotrovskiy, A., Videiko, M. and Müller, J., 2016. The new Challenge for Site Plans and Geophysics: Revealing the Settlement Structure of Giant Settlements by Means of Geomagnetic Survey. *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE*. Themes in Contemporary Archaeology 2. London, New York: Routledge, 29–54. Available from: DOI:10.4324/9781315630731

Renfrew, C., 2002. Pastoralism and Interaction: Some Introductory Questions. *In*: K. Boyle, C. Renfrew and M. Levine, eds. *Ancient Interactions: East and West in Eurasia*. Cambridge: McDonald Institute for Archaeological Research, 1–11.

Rybicka, M., 2017. *Kultura trypolska – kultura pucharów lejkowatych. Natężenie kontaktow i ich chronologia*. Rzeszow: Wydawnictwo Uniwersytetu Rzeszowskiego.

Rybicka, M., 2019. Chronology of the Funnel Beaker Culture Settlement in Western Ukraine in the Context of Radiocarbon Dating. *Archaeologia Polonia*, 57, 103–117.

Țerna, S., 2011. Aspecte ale cronologiei relative a siturilor tripoliene târzii din spațiul Pruto-Nistrean în lumina unor noi descoperiri funerare din Republica Moldova. *Peuce S.N.*, IX, 359–376.

Țerna, S., Popovici, S. and Zabolotnîi, R., 2014. Noi date despre siturile Tripolie B2/C1, C1, C2 pe teritoriul Republicii Moldova. *Memoria Antiquitatis*, 29–30, 31–87.

Țerna, S., Vornicu-Țerna, A., Hofmann, R., Dal Corso, M., Shatilo, L., Vasilache-Curoşu, M., Rud, V., Knapp, H., Kirleis, W., Rassmann, K. and Müller, J., 2019. Stolniceni – Excavation results from the 2017 campaign. *Journal of Neolithic Archaeology*, 21, 209–282. Available from: DOI:10.12766/jna.2019.9

Țerna, S., Rassmann, K., Hohle, I., Kalmbach, J., Grundmann, A., Kohle, M., 2020. Prospecțiuni geofizice pe situri Cucuteni-Tripolie din nordul Republicii Moldova. *In*: V. Vornic, ed. *Cercetări arheologice* în *Republica Moldova. Campania 2019. Sesiunea Naţională de Rapoarte, 18 aprilie 2020*. Chişinău: Comisia Naţională Arheologică, 19–21.

Topal and Țerna 2010: Топал, Д.А. and Черна, С.В., 2010. Позднетрипольский могильник и поселения у с. Кунича (Флорештский р-н, Республика Молдова) / A Cemetery and Settlements of the Late Tripolye Culture near the Village of Cunicea (Floreşti District, Republic of Moldova). *Stratum Plus*, 2010 (2), 281–298.

Videiko *et al.* 2015: Видейко, М.Ю., Чепмэн, Д., Бурдо, Н.Б., Гайдарска, Б., Черна, С.В., Рудь, В.С., and Киосак, Д.В., 2015. Комплексные исследования оборонительных сооружений, производственных комплексов и остатков построек на трипольском поселении у села Небелевка. *Stratum plus*, 2015 (2), 147–170.

Wilk, R.R., 1983. Little house in the jungle: The causes of variation in house size among modern Kekchi Maya. *Journal of Anthropological Archaeology*, 2 (2), 99–116. Available from: DOI:10.1016/0278-4165(83)90009-0

Appendix

List 1. Cunicea 1, house floor areas.

Floor area (m²)
Higher intensity
172.6
95.5
83.6
Lower intensity
190.4
160.5
182.5

List 2. Cunicea 3, house floor areas.

Floor area (m²)
Secure measurements
59.0
65.1
75.9
88.2
92.3
92.6
94.6
101.0
112.2
113.1
115.6
118.3
138.0
141.5
162.2
168.4
178.0
215.2
253.2
294.3

Floor area (m²)
Uncertain measurements
63.6
36.3
45.7
53.4
57.2
88.1
98.3
84.5
148.8
141.6
107.6
121.7
79.2
187.9
73.6
104.3
67.7
80.8
68.4
55.1
42.2
86.3
59.8
33.3
46.0
42.0

List 3. Cunicea 4, house floor areas.

Floor area (m²)
Secure measurements
88.6
183.7
226.6
251.0
275.5
Uncertain measurements
111.8
156.0
229.6

TRYPILLIA MACROSCALE

19. Radiocarbon dating: Trypillia detailed chronology, house duration estimates and the contemporaneity of earliest European mega-sites

Johannes Müller, Robert Hofmann, Wiebke Kirleis, Liudmyla Shatilo, Frank Schlütz, Mykhailo Videiko, Vitalii Rud, Stanislav Țerna†, Andreea Țerna

Abstract

In Europe, early giant settlements with a settled area of more than 100 ha are known from the Central Ukrainian Chalcolithic ca. 4100–3600 BCE. Recent environmental, geophysical and archaeological investigations confirmed the immense size of these 'mega-sites'. Nevertheless, answers to raised questions regarding population densities, carrying capacities and social developments depend on a secure chronological phasing of the phenomenon. In three test areas, the dating program for mega- and other sites was conducted. In addition to already existing data, context analyses of the sampled features allowed a secure reconstruction of the chronology including Bayesian calibration at many localities. The discovery of a clear spatial concept of settlement occupation, the contemporaneity of different investigated mega-sites, and the reconstruction of household durations and of overall site developments within local roots changed the view on Trypillia. In consequence, triggers of mega-site foundation and abandonment have been identified. The chronological models verify a high population density (not less than 37.5 p/km² in the Central Sinyukha Basin, Central Ukraine, representing the Trypillia mega-site core area during Middle Trypillia).

Introduction

The discovery of giant settlements in European prehistory is one of the most striking results of technical improvement of field survey methods within the last 20 years (cf. Gaydarska and Chapman 2022). From Andalusia to Southeast Europe and the Central

Ukraine, sites with approximately more than 100 ha have been discovered. For the interpretation of these phenomena, not only the temporal development of each site but also the temporal relation to nearby sites is of importance for answering certain questions: How big was the population in these mega-sites? How big was the population in the core areas of mega-sites? Was the carrying capacity of the environment reached at a certain stage of the development? Which environmental or social triggers are important for the foundation, development and end of these sites?

The appearance of giant settlements in different European regions is a phenomenon which is not interlinked but seems to be the result of perhaps similar structural developments in certain Chalcolithic societies. While the West Iberian giant settlements date to about 2800–2300 BCE, the Central Balkan Vinča candidates for giant settlements date to ca. 4800–4300 BCE and the Ukrainian Trypillia mega-sites to ca. 4100–3600 BCE. For Vinča, new research shows that at least contemporaneous parts of the sites were much smaller than originally thought (Raczky *et al.* 2022; Rassmann *et al.* 2021). In consequence, the Trypillia development indicates one of the most ancient appearances of mega-sites, roughly contemporaneous with early Near Eastern urbanisation processes.

The immense size of the domestic occupation area of Central Ukrainian mega-sites has not been reached in any other European region. As huge population agglomerations were postulated for the Middle Trypillia sites, both questions of early urbanisation and of the start of epidemic plagues within these demographic agglomerations have been discussed (Müller *et al.* 2016b; Gaydarska 2020; Rascovan *et al.* 2019). Furthermore, the concentric planning of huge house rings around an inner empty space as well as the discovery of special buildings motivated ideas about social planning and political organisation (Hofmann *et al.* 2019). In consequence, an environmental-archaeological research project was started, of which the evaluation of chronological information serves as the backbone for the interpretation of the Trypillia mega-phenomenon.

Archaeological samples and evaluation method

Within our still ongoing research project on Middle Trypillia mega-sites, three test regions, which represent three areas of dense Trypillia activity, are the focus of archaeological activities (Fig. 1; cf. Chapter 1: Fig. 2, this volume). The largest mega-sites are known from the Central Sinyukha Basin near Uman (Central Ukraine), where in an area of 9600 km², 12 sites measuring more than 100 ha in size cluster. In addition to geophysical surveys of many sites, larger excavations took place in Talianki, Maidanetske and Nebelivka, where different teams tried to reconstruct the activity patterns from household to site level. Detailed excavations were also carried out in Dobrovody, while in other sites with geophysical documentation, mainly small test trenches were conducted to gain dating samples (Müller *et al.* 2016b; Ohlrau *et al.* 2016; Shatilo 2021; Ohlrau 2020; Gaydarska 2020; Hofmann *et al.* 2019).

Trypillia sites range from small-scale sites to huge mega-sites. In the Central Sinyukha Basin, Maidanetske (2.00 km²) is one of the largest sites with 9 concentric house rings, two enclosures, a house-free ring corridor, an empty central space, different radial tracks that lead into the centre of the site, and public plazas (Müller *et al.* 2017; Ohlrau 2020). While most of the houses are oriented to the centre on their longitudinal axes, houses in between tracks and aside plazas could also be vertically oriented. Within the settlement, so-called mega-structures exist, which are placed at certain places which are empty of houses, at the trackways or within the open ring corridor. Altogether, 2,300 houses have been reported by their significant rectangular burnt daub remains ('ploshchadki') and house-associated pits, while about 300 further unburnt houses are recognised by their pits. Meanwhile,

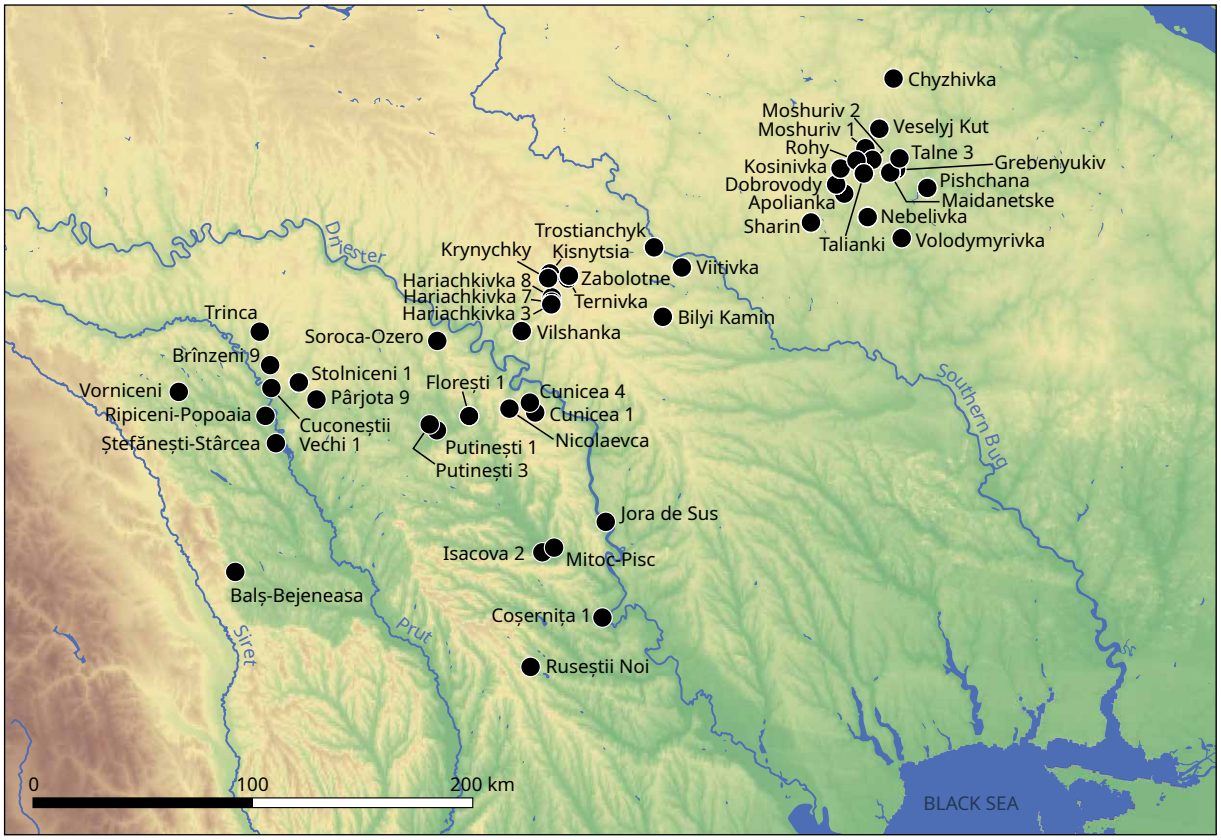


Figure 1. The distribution of sites with radiometric dates.

54 houses were excavated from 1973–2017, of which 19 had been excavated with high standards during the last 5 years.

At a distance of 15 km west of Maidanetske, Talianki (3.20 km²) is a site with a similar layout, but without special mega-structures (cf. Shatilo 2021). Geophysical features of 2,200 houses are known, 50 houses were excavated from 1989–2018. As the entire area was not surveyed, an interpolation results in ca. 1,800 houses that probably existed at Talianki. 15 km to the west, the mega-site Dobrovody (2.10 km²) has been partly surveyed and a mega-structure was excavated (Rassmann *et al.* 2014).

At further distance, the mega-site of Nebelivka (2.35 km²) has been fully surveyed, resulting in 1,445 houses that originally existed, of which 5 were excavated, including one mega-structure (Gaydarska 2020). The settlement layout is similar to the other sites.

While the mentioned sites exceed 100 ha in size, others are smaller. Within the Central Sinyukha Basin, these range from 5–100 ha, but in principle in a general division of the landscape, small and large sites are observed at a distance of about 15 km from each other.

Within the two other areas of interest, the layout of the sites is slightly different. From west to east, the size of the sites increases in general (Hofmann and Shatilo 2022). Thus, in Moldova the largest sites do not reach the large sizes of the Central Sinyukha Basin, but they are still much larger than contemporaneous smaller sites. Furthermore, the biggest sites have a circular layout, again with concentric house rings, ring corridors and an empty inner space. Mega-structures are known (Țerna *et al.* 2019; Rassmann *et al.* 2016; Uhl *et al.* 2014).

342 radiocarbon samples were taken from different contexts (Suppl. 1). These include Maidanetske with more than 90 radiocarbon datings, other sites with 20–50 dates each and such sites, where mainly a test trench was used for gaining ^{14}C dates (0–10 dates). Further published information that was used derives from sites such as Nebelivka (94 dates), Talianki (54 dates) and Petreni (9 dates). While many samples originate

from archaeological contexts, but without being further bound to stratigraphy, others are in stratigraphic order both in houses as well as in pits. Furthermore, a link to typological assemblages allows a conclusion about typochronological models that had been produced during the last 100 years of Trypillia history. In general, we concentrated our sampling strategy on Middle Trypillia mega-sites, but ^{14}C dates are also included from pre- and post-mega-site periods (Tab. 1).

The samples were calibrated individually, Bayesian models were calculated for individual contexts and sites, if possible, and the results were placed and discussed in relation to the wiggle phases of the calibration curve. The analyses were performed with the program Oxcal Version 4.4 and the Intcal 20 calibration curve (Reimer *et al.* 2020; Bronk Ramsey 2017; Bronk Ramsey 2009a; Bronk Ramsey 2009b; Bronk Ramsey 1994).

Results

Local and regional studies

The three selected test regions are localised in the western, the middle and the eastern areas of Trypillia large settlements (Fig. 1; cf. Chapter 1: Fig. 2, this volume). Depending on the scale of former or recent excavations, the documentation techniques, and the availability of datable material, the number of radiocarbon dates per site varies immensely. In consequence, the scope of possible analysis and interpretations differ from place to place. While there are four sites where the sampling strategy and the number of ^{14}C dates allowed a reconstruction of settlement processes, in others only single features, such as houses or even pits, could be dated. In general, the data can be used to reconstruct the overall dating of

Site	Number of samples	Dating (BCE)
Grebenyukiv	6	4550–4400
Chyzhivka	3	4120–3990
Dobrovody	6	3950–3700
Maidanetske	91	3970–3630
Nebelivka	96	3950–3700
Nicolaevca V	5	4530–4450
Talianki	43	3800–3600
Ternivka	2	4230–3970
Trostianchyk	15	4000–3800
Veselyj Kut	8	4070–4000
Vitivka	6	3850–3700
Vilshanka	6	4190–4080
Volodymyrivka	2	3920–3800
Zabolotone	7	4240–4080
Krynychky-Ferma	5	3620–3550
Kosinivka	12	3700–3600
Cunicea	2	3400–3200
Stonicieni	53	3980-3720
Petreni	9	3950–3800

Table 1. Number and chronological distribution of ^{14}C dates per site, from selected sites.

Trypillia phases as well as site formation processes, especially of larger sites. The results are listed according to the three test regions and within them according to the dating sequence from old to young.

Middle-Dniester region (Moldova and East Romania)

The western distribution area of Trypillia is composed of loess plateaus and larger river systems in present day Rumanian Moldova and Moldova. From west to east, the Suceava and Moldovan plateaus and the Upper Siret, Upper Prut and Middle Dniester main rivers are involved within the forest steppe environment.

Precucuteni and Cucuteni

From **Nicolaevca V**, 4 samples from a 'pit-house', pits and a step surface belonging to (early) Precucuteni 3 (PCC 3) could be dated (Fig. 2). Stratigraphic information is gained from two pits, which are located under a burnt house, and the step surface near the house. The sum calibration resulted in a possible duration of the site ranging from ca. **4550**–**4450 BCE**. In detail, the Bayesian calibration of the three samples in stratigraphic position (a pit cut by a younger pit and both beneath the step surface) resulted in a very good fit of the model (A_{model}=117.9; $A_{overall}$=116.1) and a duration ranging from **4530**–**4450 BCE** (medians).

Beside the statistical observation, the position on the calibration curve describes the main part of the probabilities on the steeper part of the curve, while a smaller proportion also might belong to the flat part until **4375 BCE**. Two samples from Nicolaevca V belong to an LBK long pit of a longhouse and date from ca. 5200–5000 BCE.

Other new samples from Precucuteni 2 (PCC 2) sites (Suppl. 1), such as Balș-Bejeneasa (4690–4560 BCE, 1σ), Floresti I (4580–4470 BCE) or Floresti III (4690–4560 BCE), and Precucuteni 3 sites, such as Isacova II (PCC 2–3, 4690–4560 BCE), Coșernița I (PCC 3, early, 4610–4460 BCE), and Putinești I (PCC 3, 4680–4535 BCE), do not differ statistically from the PCC 2 datings. Only Rusestii Noi I (PCC 3-CC A1, 4490–4370 BCE) dates later and signifies the change to Cucuteni A1 (CC A1), probably around 4450 BCE.

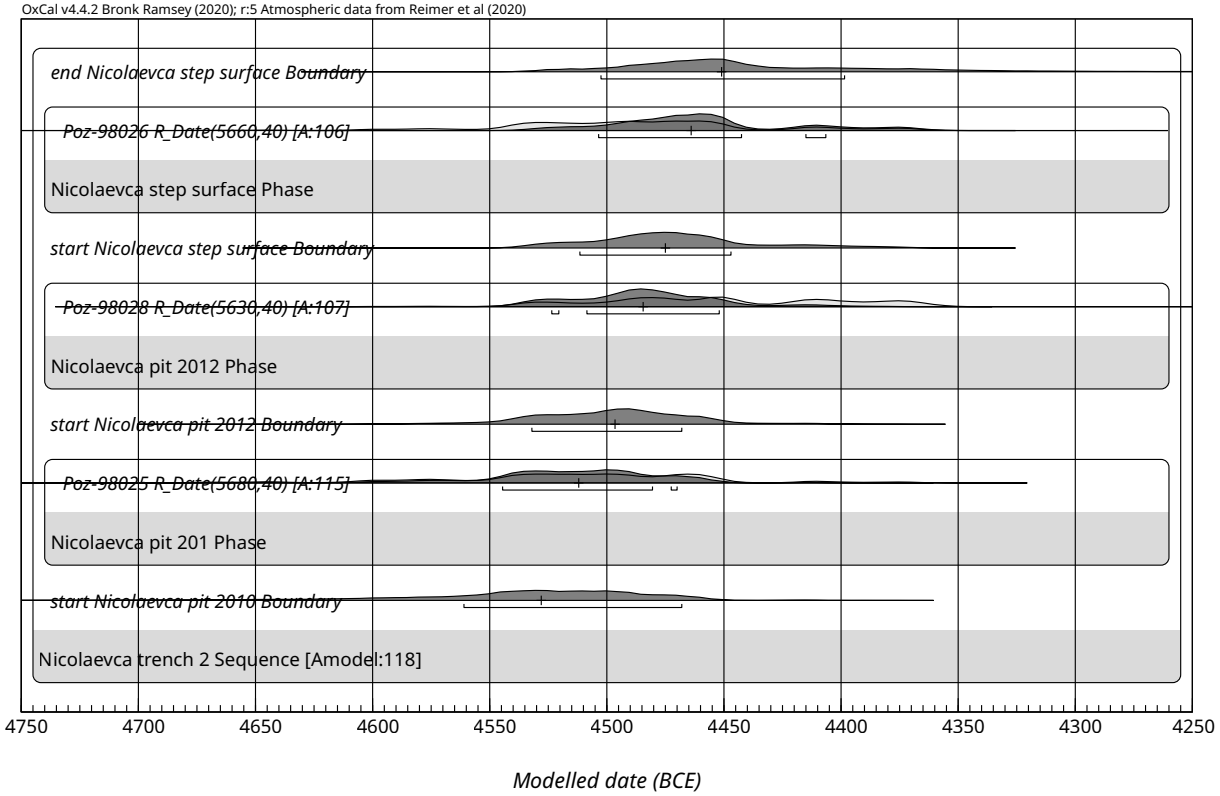


Figure 2. The Bayesian calibrations of Nicolaevca V stratigraphy (cf. Suppl. 1–2).

In comparison with the general ideas on Precucuteni and Cucuteni dating (Mischka *et al.* 2019, 116, Fig. 2) the results are slightly younger[1]: PCC 3 is not securely dated to 4775–4650 BCE as expected, but to Nicolaevca V from ca. 4550–4450 BCE. The other dated PCC 3 site might imply the possibility of a start of PCC 3 around 4600 BCE. In principle, all newly dated PCC 3 sites cover dating intervals on the calibration curve from 4690–4600 BCE (flat) and the steep ones until 4550 BCE. Similar parts of the calibration curve are covered by PCC 2 sites such as Balș-Bejeneasa (4690–4560 BCE, 1- σ), Floresti I (4580–4470 BCE) or Floresti III (4690–4560 BCE). They are also much later than expected (4900–4775 BCE) and overlap completely with PCC 3.

CC A1 (expected 4600–4500 BCE) dates later at Rusestii Noi I (PCC 3-CC A1, 4490–4370 BCE), but together with other CC A sites, CC A includes the dating intervals at least until 4150 BCE. The described differences might be due to the use of samples with old wood effects within the older samples.

Trypillia

For Trypillia, the dates from **Cucuteni A/Trypillia B1** sites also indicate the dating of CC A until probably 4300/4250 BCE: Jora de Sus (CC A/B1), 4350–4260 BCE; Putinești III (CC A/B1), 4330–4180 BCE and Cuconeștii Vechi I (CC A/B1), 4340–4250 BCE. In consequence, **Trypillia B1** is dated on the two calibration intervals between ca. 4330 BCE and 4180 BCE.

Trypillia B1/B2 sites are slightly later: Vorniceni (B1–B2), 4320–4070 BCE; Ripiceni-Popoaia (B2 or B2/C1), 4040–3975 BCE; Mitoc-Pisc (B2 or B2/C1), 3950–3800 BCE. The date for Brînzeni IX (B2), 3970–3810 BCE, seems to be quite late.[2]

Trypillia B2 is dated to Brînzeni VIII (B2), 3970–3810 BCE, as expected. The same applies to Ripiceni-Popoaia (B2 or B2/C1), 4040–3975 BCE and Mitoc-Pisc (B2 or B2/C1), 3950–3800 BCE, so that we expect a range from **4040–3800 BCE.** Trypillia B2/C1 is dated in Petreni with 9 radiometric datings from **3890–3820 BCE** (medians; A_{model}=94.2; $A_{overall}$=96.7; Fig. 3).

Trypillia C1 dates between **3950 BCE and 3710 BCE, perhaps 3660 BCE**, about 150 years earlier than expected. The dating of C1-sites is congruent with the results from Stolniceni (3950–3700 BCE), where the bulk of dates can be used for detailed studies on the settlement (see below): Soroca-Ozero (C1), 3960–3810 BCE; Trinca (C1), 3890–3710 BCE; Pârjota IX (C1 late) 3760–3660 BCE and Ștefănești-Stârcea (C1–C2), 3940–3780 BCE[3].

For **C2**, the site of Cunicea 4 (C2) yielded two ^{14}C dates from a house and a pit, dating between 3490 BCE and 3040 BCE.

Summing up, in the western Trypillia area we would estimate the following phases: PCC 3/2 4690–4500 BCE and CC A1 4450–4300 BCE; Trypillia B1 4300–4150 BCE; Trypillia B1/2 4300–4000 BCE; B2 4050–3950 BCE; C1 3950–3700 BCE and C2 3490–3040 BCE (Fig. 4).

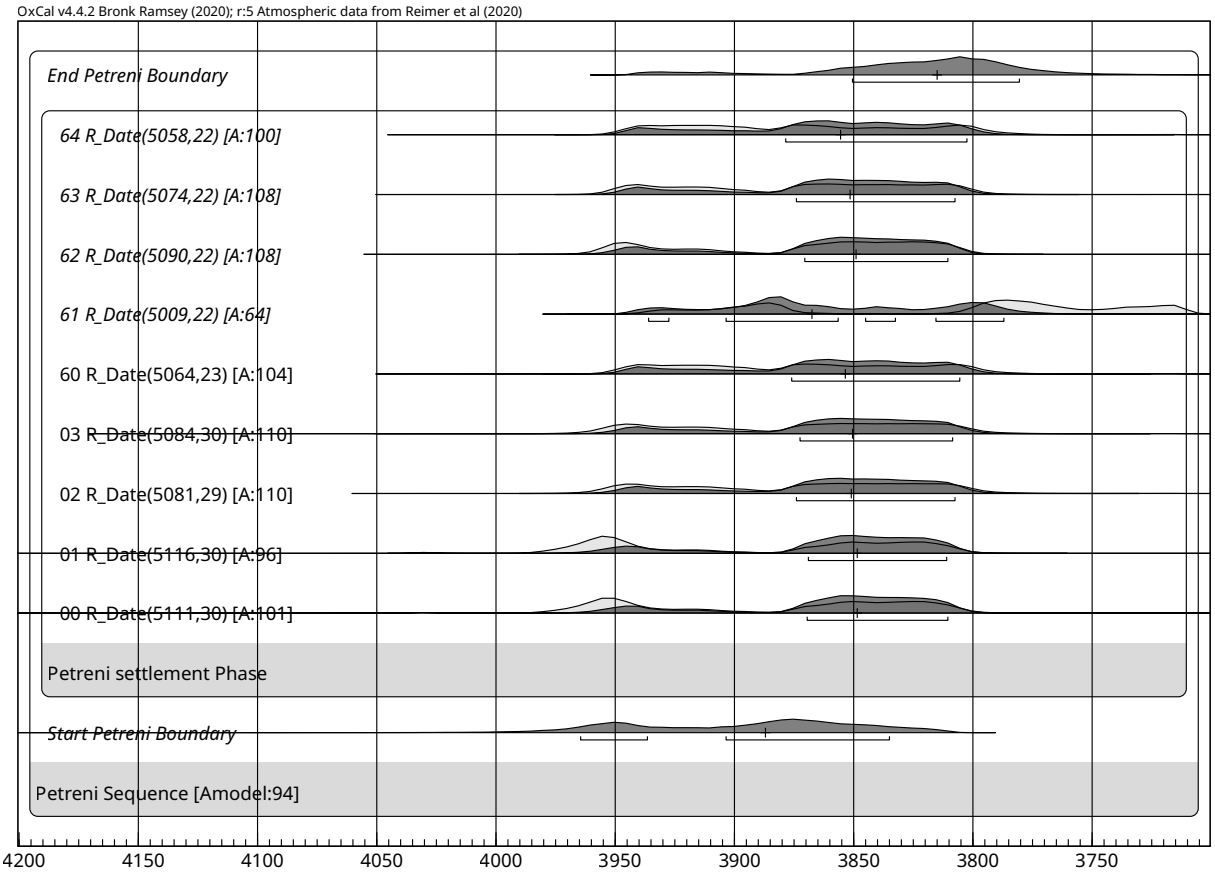
Figure 3 (opposite page, above). The Bayesian calibrations of Petreni (cf. Suppl. 1–2).

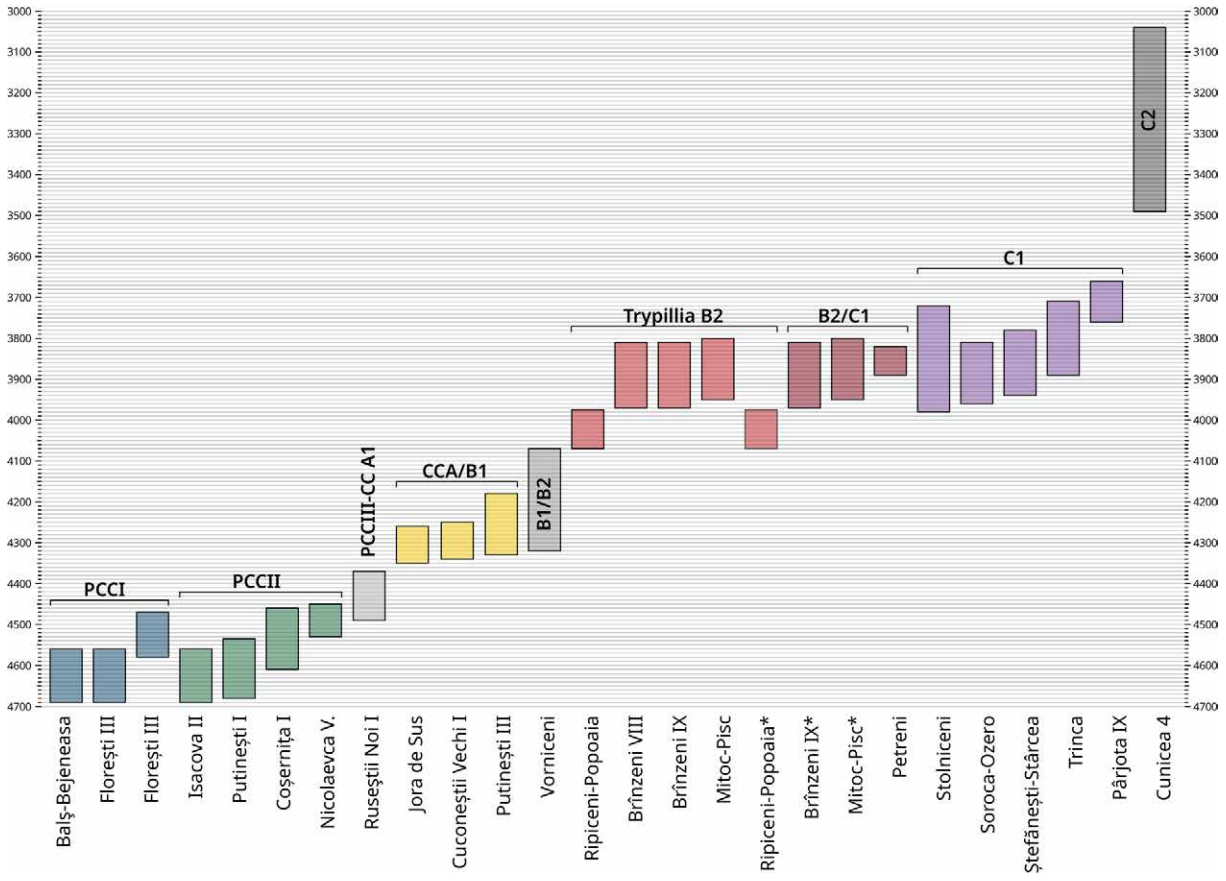
Figure 4 (opposite page, below). The comparison of Bayesian dates of individual sites from Middle-Dniester region.

1 PCC 5000–4600 (PCC 1 5000–4950, PCC 2 4900–4775, PCC 3 4775–4650), Cucuteni 4600–3550: Cucuteni A 4600–4050 (A1 4600–4500, A2 4500–4150, A3 4150–4050), CC A–B 4050–3800 (alpha, beta 4050–3900; gamma, delta 3950–3800), CC B 3800–3500 (CC B1 (epsilon) 3800–3650, CC B2 (3650–3500)).

2 In Brînzeni IX (C2), a date has been obtained from an antler tool, which may have been collected in prehistory from the settlement Brînzeni IV (B2/C1) located very close just on the other bank of a small stream. If so, the ^{14}C date would perfectly fit the expectations for this Trypillia B2/C1 site.

3 In this case, the date seems too old, but there is the possibility that it comes from a Trypillia C1 site (Ștefănești-Stânca). The materials have been subsequently mixed in the museum collections. If so, the ^{14}C date would perfectly fit the expectations for this Trypillia C1 site.


OxCal v4.4.2 Bronk Ramsey (2020); r:5 Atmospheric data from Reimer et al (2020)
End Petreni Boundary
64 R_Date(5058,22) [A:100]
63 R_Date(5074,22) [A:108]
62 R_Date(5090,22) [A:108]
61 R_Date(5009,22) [A:64]
60 R_Date(5064,23) [A:104]
03 R_Date(5084,30) [A:110]
02 R_Date(5081,29) [A:110]
01 R_Date(5116,30) [A:96]
00 R_Date(5111,30) [A:101]
Petreni settlement Phase
Start Petreni Boundary
Petreni Sequence [Amodel:94]
4200
4150
4100
4050
4000
3950
3900
3850
3800
3750
Modelled date (BCE)


PCCI
PCCII
PCCIII-CC A1
CCA/B1
B1/B2
Trypillia B2
B2/C1
C1
C2
Balș-Bejeneasa
Florești III
Florești III
Isacova II
Putinești I
Coșernița I
Nicolaevca V.
Ruseștii Noi I
Jora de Sus
Cuconeștii Vechi I
Putinești III
Vorniceni
Ripiceni-Popoaia
Brînzeni VIII
Brînzeni IX
Mitoc-Pisc
Ripiceni-Popoaia*
Brînzeni IX*
Mitoc-Pisc*
Petreni
Stolniceni
Soroca-Ozero
Ștefănești-Stârcea
Trinca
Pârjota IX
Cunicea 4

Stolniceni (C1)

Stolniceni is one of the few Moldovan Trypillia sites, where after geophysical surveys, a concept of test trenches and main trenches was applied during field surveys and excavations (Țerna *et al.* 2019). In consequence, the site enables information on its internal chronological development (Figs. 5–10).

In detail, the following information can be noted for Stolniceni (cf. Suppl. 1-2):

- There are four dates from kilns (Suppl. 2: Fig. S13): They are set at ca. **3930–3810 BCE** (median of boundaries of kiln from Trench 5) and ca. **3945–3870 BCE** (median **3870 BCE** for the kiln in Trench 3), but are positioned within a flat part of the calibration curve. From the kiln in Trench 3, Poz-87976 belongs to the fill of the firing chamber or one of the channels. From the kiln in Trench 5, Poz-97940 and KIA-52653 belong to the fill of the firing chamber, additionally also the human bone of Poz-128150. Therefore, they probably indicate an infilling event just before or after the final use of the kiln, for which the highest probability is around **3870/3860 BCE** (median and mean).
- Several dates on the 3-ditch and palisade system of the site are available (Suppl. 2: Fig. S12). If we follow the statistical probabilities, activities took place from ca. **3900–3790 BCE** (median boundaries). Two samples belong to the inner palisade that dates very close between **3885 BCE and 3856 BCE** (medians). The outer ditch is also roughly dated by two samples from different parts of the lower infill, around **3885–3850 BCE.** The lower level of the original about one-metre deep ditch was interpreted as a sediment with continuous infilling (Țerna *et al.* 2019b). Two radiocarbon dates from the middle and inner ditch indicate a similar time scale (medians: **3875 BCE**). In summary, the ditch and the palisade system were probably filled in during the first half of the 39th century BCE[4].
- Two samples come from a settlement pit from the vicinity of the palisade-ditch system (Țerna *et al.* 2019b). Both date the major deposition event identified in the middle part of the pit's infill. They show a long duration between **3950 BCE and 3600 BCE** (median of boundaries), which – if not distorted by the calibration curve – might indicate the use of the pit during two phases. The infill might have started during the earliest activities at the site (indicated by the dates of the palisade and kilns), then the pit was left open and refilled towards the end of the site occupation.
- Pit 5 also dates within the 39th century BCE (**3920–3870 BCE**, means), more or less contemporary with the adjacent kiln. Pit 6 has a mean around 3870 BCE, dating from **3950–3800 BCE,** an age which is overruled by the one sample from the step-surface with a mean around **3920 BCE,** dating from **3980–3820 BCE**.
- Seven samples were taken from different filling events of Pit 20 (Fig. 6). These samples include two from the bottommost layers, one from the first major deposition event, two from the second deposition event, one from an intermediate layer between the two events, and the last one from the uppermost layer, marking the end of the pit use. The stratigraphical modelling of the dates indicates a duration of the feature from **3920–3840 BCE** (median of boundaries).
- 4 dates belong to the circular structure, dating with the early structure pit within the 39th century (**3900–3830 BCE**, means) and the use of the circular surrounding until **3770 BCE** (mean). Moreover, the mean of the boundaries of all dates together indicate a duration from **3890–3750 BCE** (Fig. 7).
- For Trench 19, three dates are available for the large pit associated with House 19 ('alpha house') and one date for a smaller pit located northeast of the main one (Fig. 8a; cf. Suppl. 2: Fig. 16). Two samples from the main pit date two of the

4 The real date might be hampered by the wiggle of the calibration curve, which also might imply an earlier construction.



Figure 5. Stolniceni: Radiometric dates and the settlement model. The occupation of the inner areas seems to develop later.

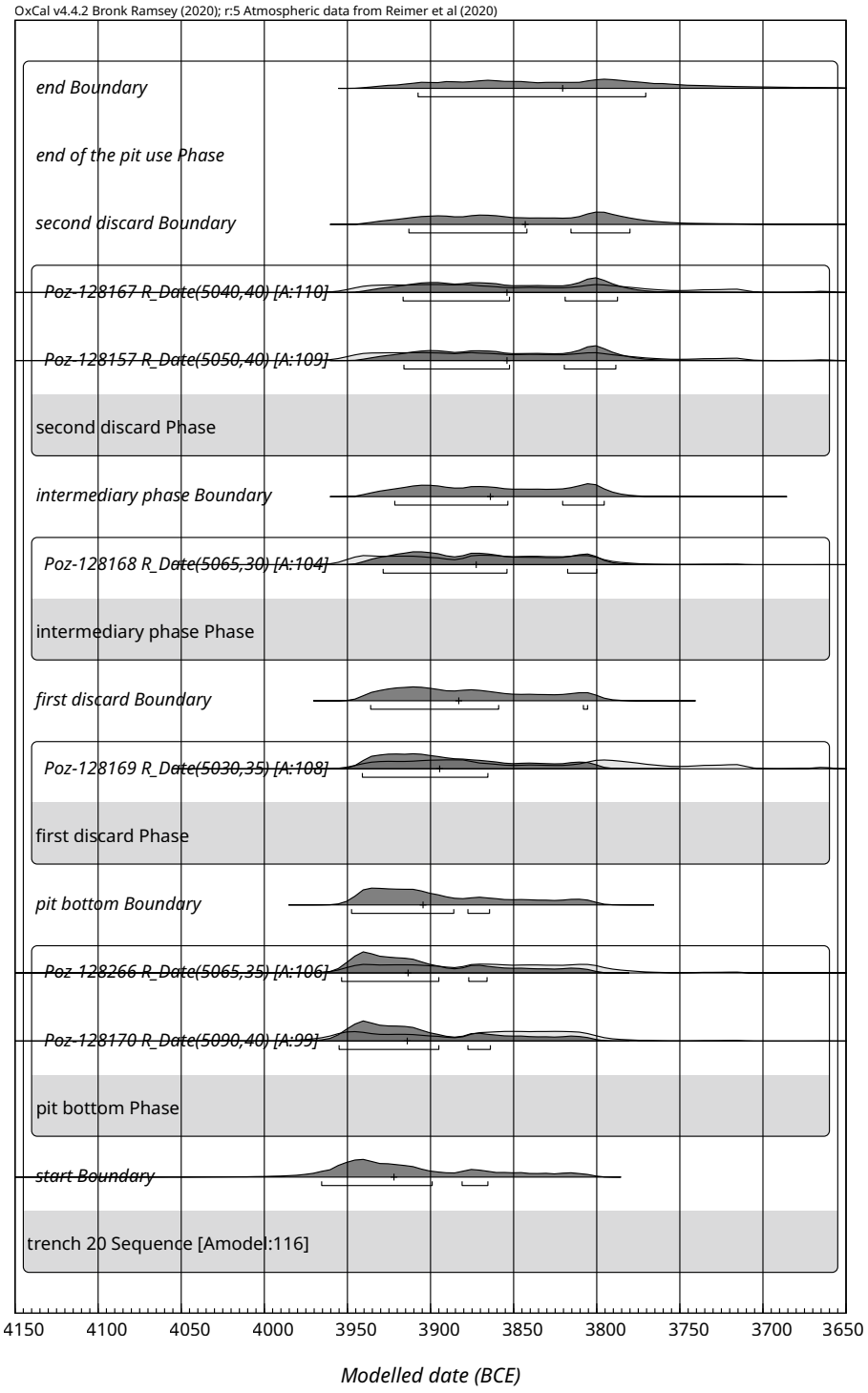


Figure 6. The Bayesian calibrations of usable samples from Stolniceni Pit 20 (cf. Suppl. 1–2).

lower layers, which correspond to the first massive deposition event (but not the first intentional infill), potentially linked to the early activity of the nearby house. The third sample was taken from the uppermost layer of the pit, which contains sediments naturally deposited after the nearby house's lifecycle had ended. Based on the dates obtained, the first major deposition event took place between **3920 BCE and 3800 BCE** (medians of boundaries), while the filling of the pit ended before **3670 BCE** (median).

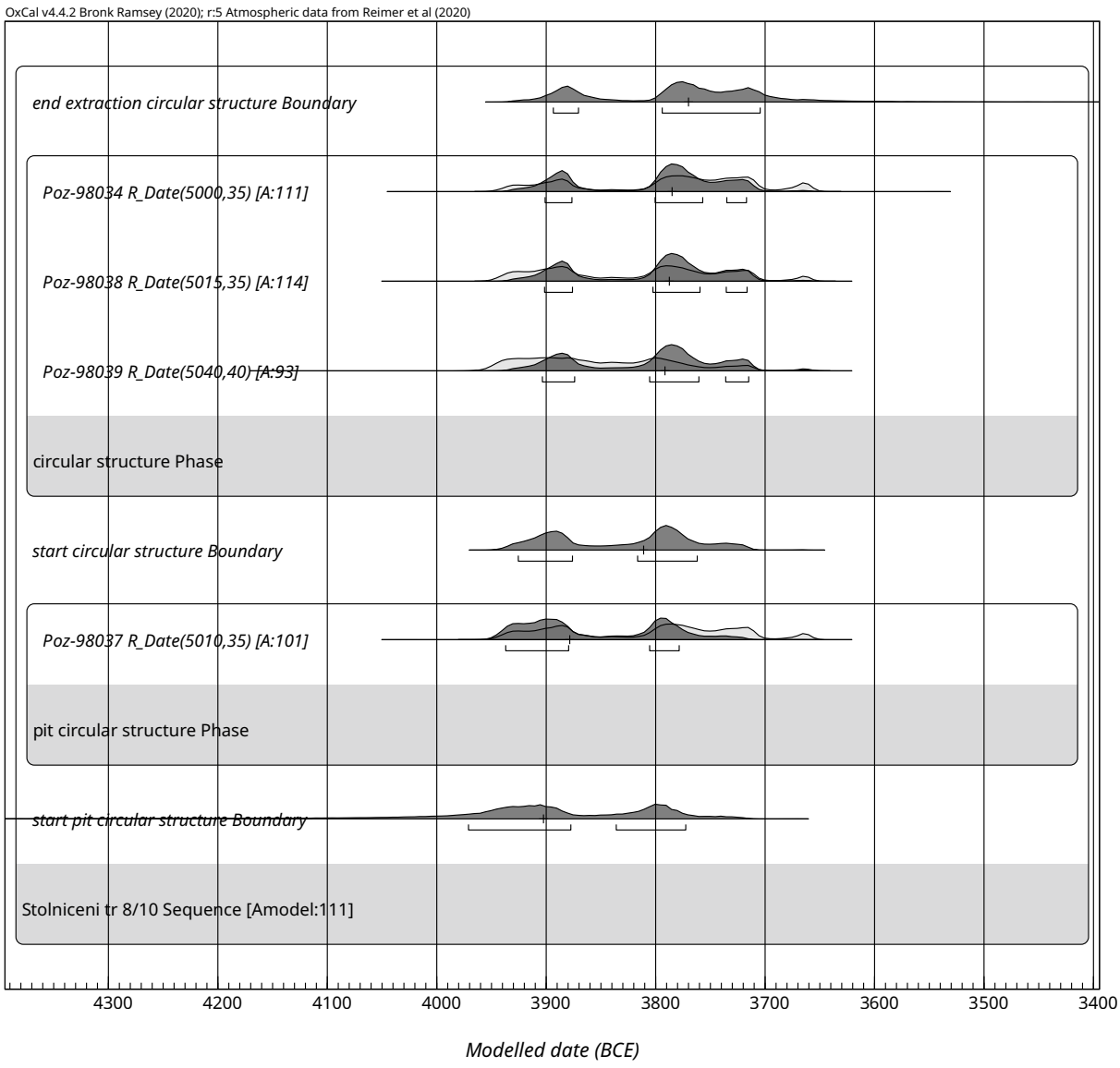


Figure 7. The Bayesian calibrations of Stolniceni circular structure (cf. Suppl. 1–2).

- Regarding the small pit situated north of the main one, the sample Poz-12815 was obtained from the bottommost layer, representing the very first infill, and it dates to **3942–3765 BCE** (median 3815 BCE). This indicates that the small pit was operational during the same period as the main pit.
- Four samples belong to House 7, which date within a sequential occupation with one sample for the original surface (**3930 BCE**), and the extraction pit from **3870–3830 BCE** to **3830–3780 BCE** (mean of boundaries). The duration of the house is calculated to a mean of **50 years**. Three other houses are dated with one ^{14}C date each, but they fall into a similar range (means: **3875 BCE** (House Trench 13 west), **3870 BCE** (House Trench 12), **3690 BCE** (House Trench 11)). If modelled together without the house from Trench 11, the duration of the house occupation is between **3920 BCE and 3820 BCE**.
- Four samples were used to determine the age of the pit associated with the mega-structure excavated in Trench 21 (Fig. 8b). Additionally, there is another date, Poz_128216, collected from a later pit that intersects the main feature at its western edge. The main pit itself contains several re-cuts, which are not clearly reflected by the ^{14}C sampling strategy. Thus, in the sequential calibration we con-

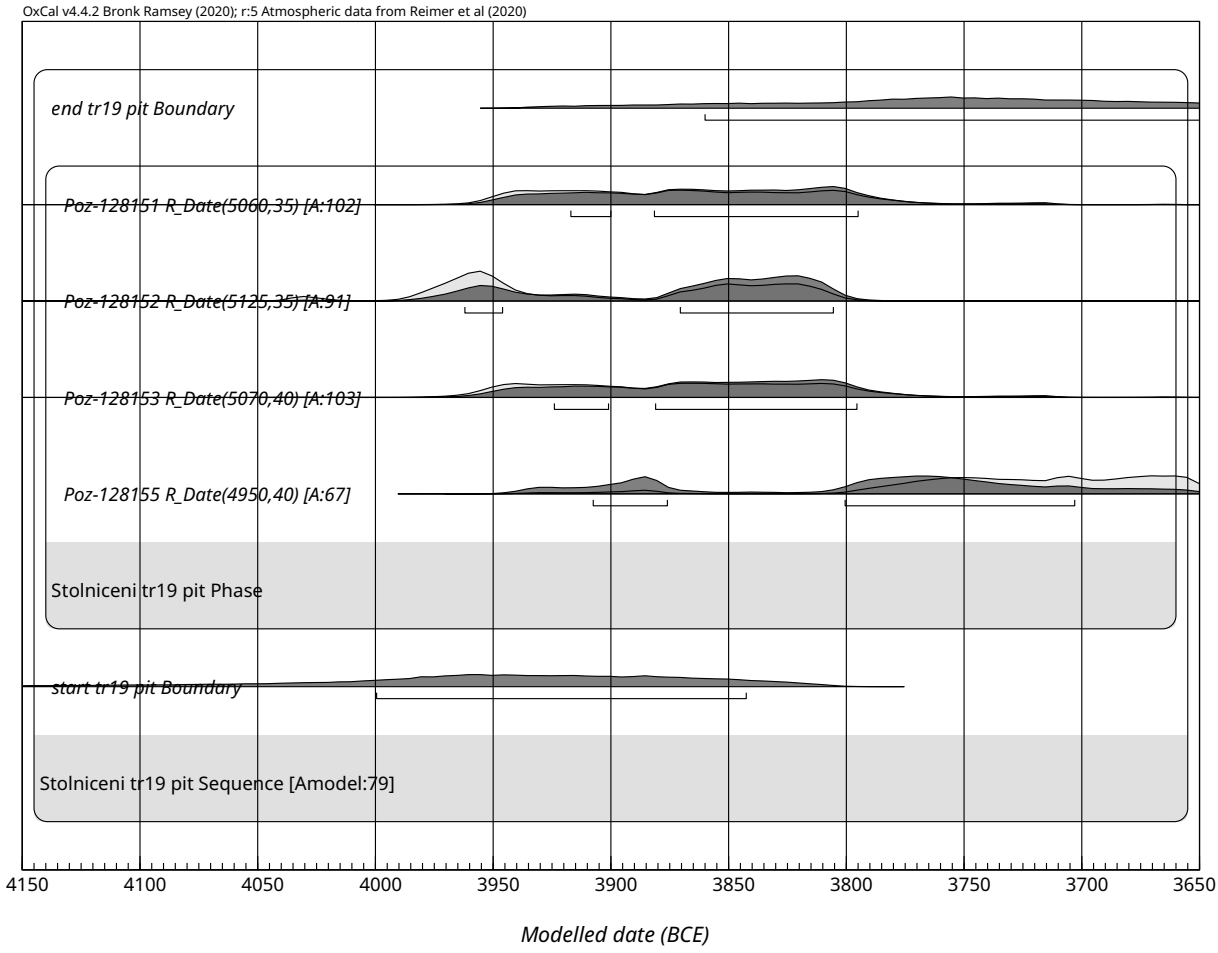


Figure 8a. The Bayesian calibrations of Stolniceni alpha pit (cf. Suppl. 1–2).

sidered only the depth of the samples. The dates show that the pit's duration spans between **3930 BCE and 3790 BCE** (median of boundaries). As for the second pit, it is dated to **3940–3770 BCE** (**3885 BCE**, median), which means that the filling of the second pit started after the one of the main features.

- One sample from the layer at one of the trackways displays a date around **3800 BCE** (mean, with 60.9% 3800–3710 BCE).
- Dealing even only with 56 samples and only a few stratigraphical orders, some tendencies are obvious. While we have to consider the data by themselves, on the one hand, and the depositional processes, on the other hand, the structure of the calibration curve also influences our probabilities and limits the value of our estimations. With respect to the datings from Stolniceni, three dating intervals of the calibration curve are of interest: A 4020–3950 – the calibration slope; B 3950–3790 – the main wiggle plateau; C 3790–3690 – a plain calibration curve part below the values from A and B.

Some surface activities, the kilns, some pits and the palisade around the settlement might have started around 3950 BCE, at the latest at 3900 BCE. But even if the statistical values might indicate such an early start, because of the calibration curve we cannot exclude the possibility of a much later dating that still lies before 3800 BCE.

Other dates – namely for the inner and middle ditches, the road and some houses – are later than 3800 BCE, but before 3700 BCE. Both for the houses and the circular structure, an existence through the early 39th century BCE and the late 38th century BCE at Stolniceni is probable.

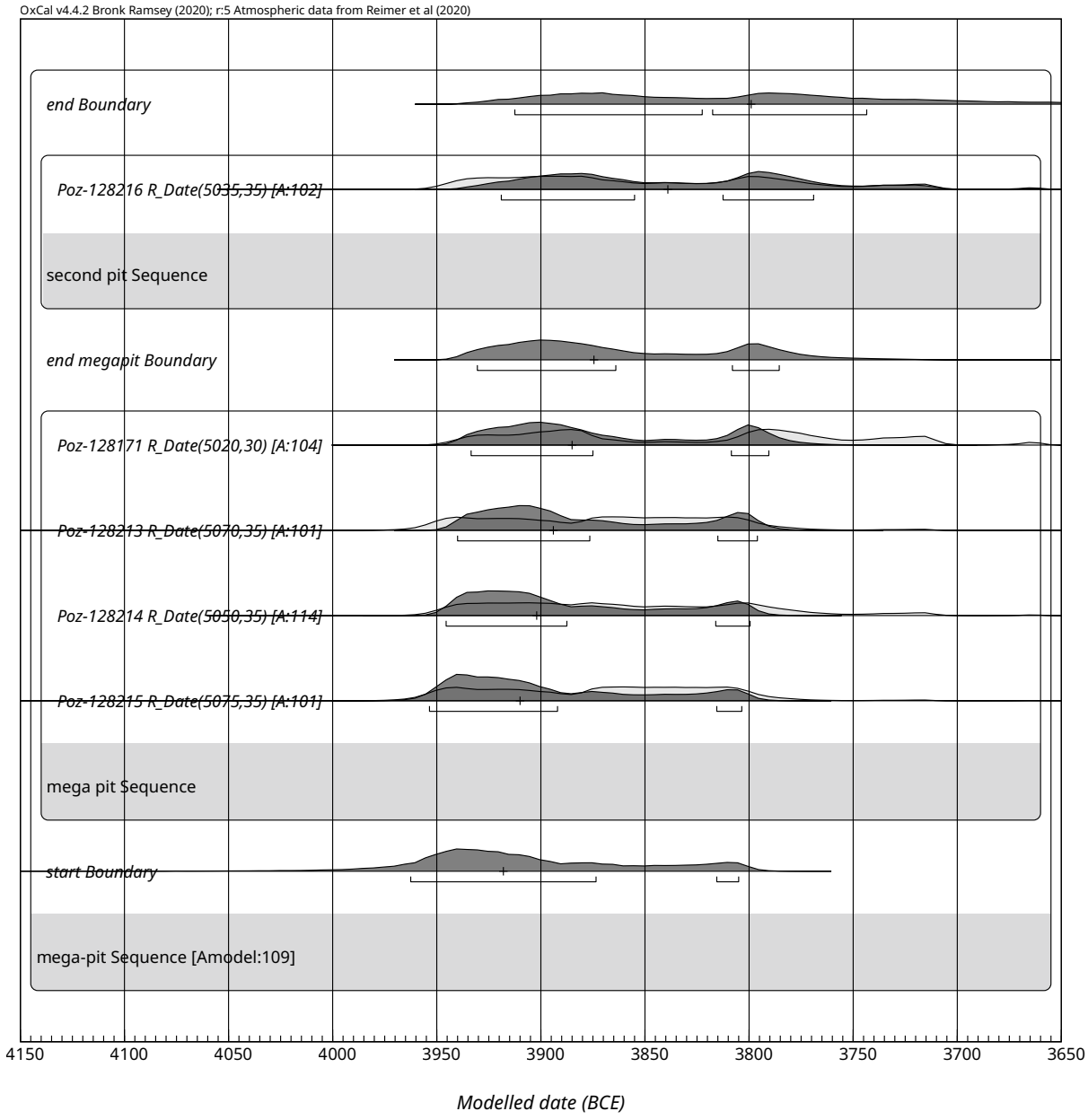


Figure 8b. The Bayesian calibrations of Stolniceni mega-structure pit (cf. Suppl. 1–2).

Figure 9. The Bayesian calibrations of Stolniceni, all features (cf. Suppl. 1: Fig. S15).
Due to the length of this figure, for ease of viewing it is only available online (https://doi.org/10.57892/100-55).

In consequence, Stolniceni is dated to the 39th and 38th centuries BCE. As no samples exist directly from houses, which are dated before 3950 BCE, a dating before 3950 is difficult to securely argument for (despite other single dates). Furthermore, because of the wiggle-structure, the tendencies for differences in the dating of specific contexts are similarly difficult to explain, even if the sum calibration curves support such a view.

Nevertheless, the palisade, the kilns and the pits clearly indicate an early demarcation of the place by an enclosure, an early installation of infrastructural elements and early domestic activities. In principle, these datings might be also associated with first house constructions. During the course of time, the 'filling' of the enclosed space, the enlargement of the enclosure with a ditch system and the installation of the circular structures took place. In this respect, the tendencies within the ^{14}C dates indicate a realistic scenario for the development of the site (Fig. 5 and 9).

For the reconstruction of demographic developments, the data was mapped along the main three wiggle-phases (Fig. 10). Only two dates from two locations (not deriving from a house) are known before 3950 BCE, 42 from 13 locations (of these

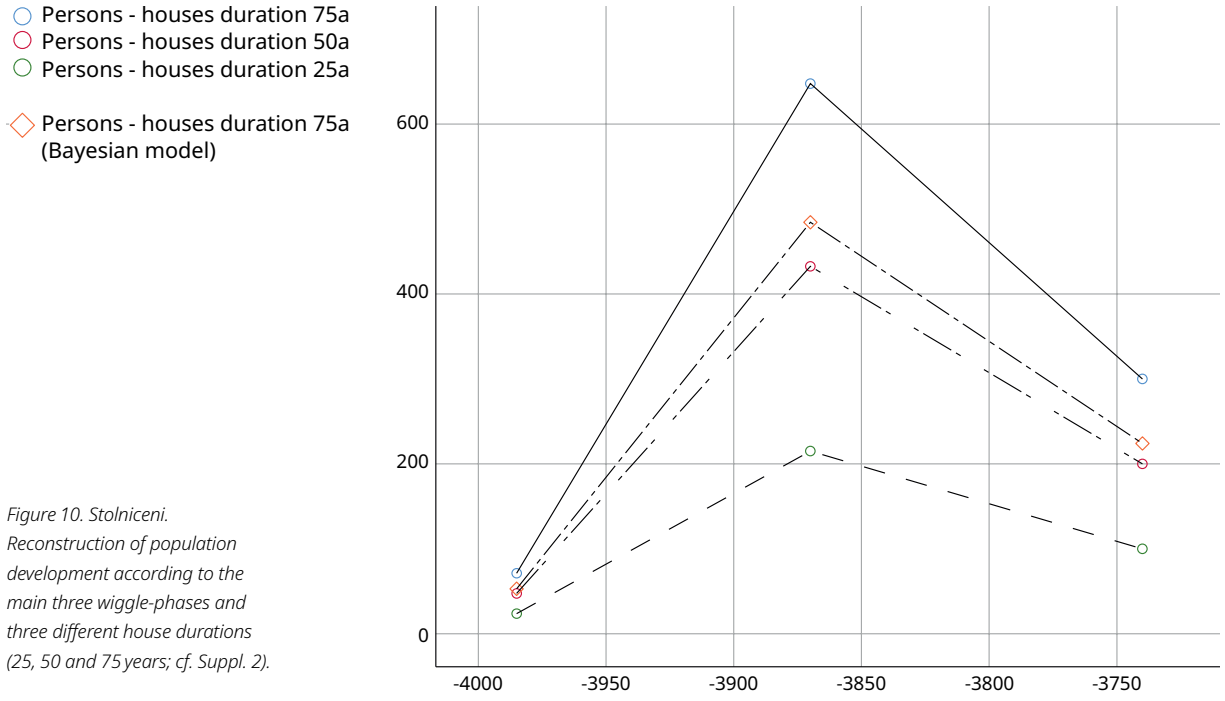


Figure 10. Stolniceni. Reconstruction of population development according to the main three wiggle-phases and three different house durations (25, 50 and 75 years; cf. Suppl. 2).

five houses) from the phase 3950–3790 BCE and 12 from 9 locations (of these three houses) are known from ca. 3790–3690 BCE. This distribution is based on a mapping of single dates, the Bayesian sequences do not change the distribution pattern.

The overall Bayesian model for Stolniceni also describes a duration of the site between **3980 BCE and 3720 BCE** (median boundaries; A_{model}=76.7; $A_{overall}$=72.2). Until around 3900 BCE, the spatial distribution displays all activities concentrated between the ring corridor and the outer enclosure, while later the activities also include the inner sector between the ring corridor and the free central place. Additionally, the circular structures outside of the fortification were also used.

With the data at hand, we are also able to reconstruct the demographic development of Stolniceni. We have to take the uneven duration of each of the three Stolniceni phases (absolute years: Phase 1: 70; Phase 2: 160; Phase 3: 100) as well as the differences in the distribution of the ^{14}C dates (Phase 1: 2; Phase 2: 42; Phase 3: 12) into account. Furthermore, the lifespan of a house might be estimated to 25, 50 or 75 years, what also influences the contemporaneity of houses. The basic values are represented by the 370 houses that were detected by geophysical investigations and were partly excavated. In consequence, three steps are necessary for the calculation:

1. ($\sum^{14}$C phase * $\sum$houses site) / $\sum^{14}$C site = a
2. phase duration (a) / lifespan house (a) = b
3. a/b = c (number of contemporaneous houses)

With this formula, the probability is high that during Stolniceni Phase 1 about 9.5, during Phase 2 ca. 86.5 and in Phase 3 ca. 40 houses existed contemporaneously, if the lifespan of a house is set to 50 years. If we calculate with a lifespan of 25 or 75 years for each house, the figures shift adequately (Fig. 10). If we assume that there were 5–10 residents per house, the population size of Stolniceni varies from ca. 47.5–95 inhabitants (Phase 1) to 432.5–865 inhabitants (Phase 2) and to 200–400 inhabitants (Phase 3) for a house lifespan of 50 years.

These calculations are based on the critical examination of all ^{14}C dates and their mapping according to the wiggle-phases (Phase 1: 4020–3950; Phase 2: 3950–3790; Phase 3: 3790–3690 BCE), which ends up with a duration of 330 years for the whole

site. Taking the Bayesian calibration model for all dates from Stolniceni into account, the site duration is modelled to have been 40 years shorter (3980–3720 BCE: 290 years). In consequence, the actual population size might have been about 12% higher than calculated here, as the Bayesian time span of the site is about 12% shorter than the single ^{14}C calculation[5]. Thus, we would estimate 53–106 inhabitants (Phase 1) to 484.4–986.8 inhabitants (Phase 2) and to 224–448 inhabitants (Phase 3) for a house lifespan of 50 years.

Southern Bug-Dniester interfluve (Western Ukraine)

In today's Western Ukraine, the forest steppe areas between the Middle Dniester and the Middle Southern Bug, mainly composed of the Podolien Uplands, display a distinctive cluster of Trypillia sites.

Zabolotne and Ternivka (B1–B2)

At Zabolotne, test trenches within the 40-ha concentric site with 2 central mega-structures provided 7 dated samples, of which one came from an area outside of a house and 6 from a pit with stratigraphic order (Fig. 11). The data from the pit could be used for a Bayesian model because of the stratigraphy. While 2 data samples from the Kiel lab did not fit the model, the others fitted roughly. The range **4250–4080 BCE** (A_{model}=86.5; $A_{overall}$=88.7) does mainly fall within the dating interval 4220–4050 BCE. The single date from the vicinity of another house (Poz-97918, Context 3002) dates younger into a time interval 3650–3530 BCE, which might indicate a later activity.

From the 7-ha site Ternivka with a concentric plan and one large mega-structure, two samples are available from a house layer (1003) that was partly recovered in a test trench (Suppl. 2: Fig. 1). The two dates fall within the boundaries from **4210–3970 BCE** (medians), respectively **4080** and **4050 BCE.** The dates fall within the dating intervals 4220–4050 and 4050–3970 BCE, making a more secure dating difficult.

Ternivka and Zabolotne are topographically directly opposite from each other on different sides of the small Berezhanska canyon. A third site (Soniachne) was discovered between both sites. Interestingly, according to radiometric dating, they existed contemporaneously. In Ternivka, the dating is from the inner circle, in Zabolotne from an interior house of the second ring, which borders the ring corridor.

Vilshanka (B1–B2)

From the 25-ha site with a concentric plan and 1 mega-structure, 6 dated samples from the profiles of two pits are available (Fig. 12). The pits belong to houses in the southwest associated with the outer area of the settlement. They fall within a range from **4190–4080 BCE** (median; A_{model}=104.9; $A_{overall}$=105.3), with single ranges around **4130 BCE**. All dates belong to the dating interval **4220–4050 BCE**.

Hariachkivka 3, 7, 8 (B1–B2)

According to the geophysically surveyed area, the main structure at the settlement Hariachkivka 7 is the arc-like row of the buildings. The south end of the arc is located on the edge of the slope to the river valley, which lies between settlements Hariachkivka 7 and 8 (Chapter 14, this work, Vol. II). The site measures 5.5 ha. Hariachkivka 3 is a site of approximately 7 ha size. House rings, a ring corridor, a mega-structure and a free inner space have been detected. Hariachkivka 8 is a site measuring 7.5 ha and displays the concentric planning principle.

From Hariachkivka 8 (Fig. 15), two dates from a house (median of boundaries: **4380–4170 BCE**, but median of dates 4268 and 4287 BCE) and four and three dates

5 330 a - 290 a = 40 a - (40*100)/ 330 = 12.12%

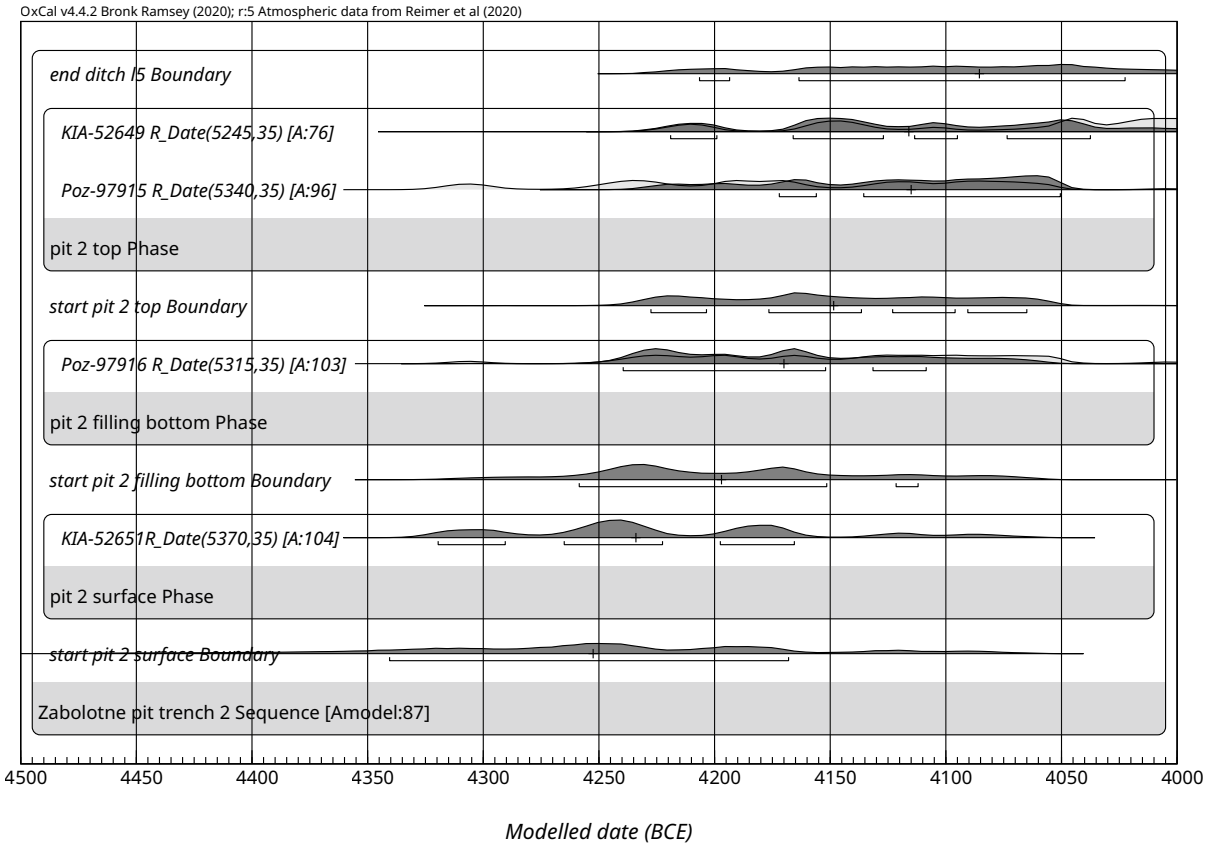


Figure 11. The Bayesian calibrations of Zabolotne (cf. Suppl. 1–2).

from two pits, respectively (median of boundaries: **4210–4070 BCE**; **4210–4060 BCE**) describe a dating mainly between **4270 BCE and 4060 BCE**. At Hariachkivka 3, four dates from a pit date to ca. **4045–3955 BCE** (median of boundaries; A_{model}=112.8; $A_{overall}$=113.4; Fig. 13), at Hariachkivka 7, three dates from a bottom of a pit date to **4230–4065 BCE** (A_{model}=101.3; $A_{overall}$=101.9; Fig. 14).

Trostianchyk (B2)

The 3-ha site of Trostianchyk is located on a promontory with one mega-structure. 15 dated samples are available from four pits and one oven. Within each of these features, the stratigraphic order of different contexts was documented, so that Bayesian statistics integrated this information into the dating model (Fig. 16). The site features are dated from **3975–3955 BCE** (medians). The oven and the pits (each **3970–3960 BCE**) all fall within a steep range of the calibration curve. The sharp

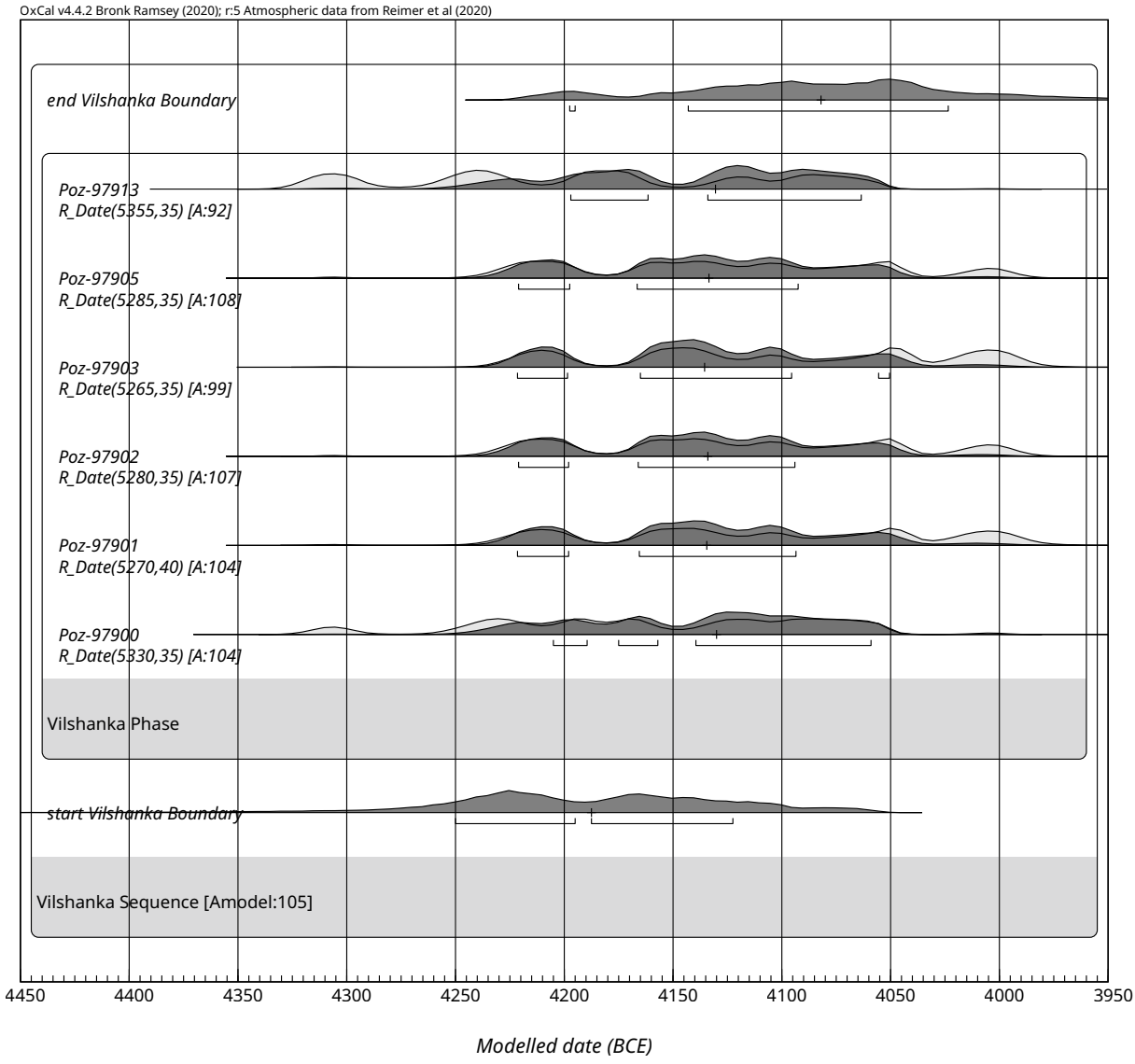


Figure 12. The Bayesian calibrations of Vilshanka (cf. Suppl. 1–2).

dating is due to the secure dating interval 3990–3950 BCE (steep calibration curve) and the ^{14}C dates are additionally modelled based on their stratigraphic position.[6]

6 'Three successive stages of the pit 1 filling were dated, although the lowest infilling layer was excluded from this due to a lack of datable sample material. Sample Poz-87490 was associated with the massive clay objects in the middle-lower part of the pit at the border between layers 3 and 2B. The sample Poz-87488 is related to an event of pottery infilling in layer 2A. The sample Poz-87489 dates the upper part of layer 2A. The modelling of these dates resulted in a very robust model with the high overall probability of 153.2. According to this model, the backfilling of the pit took place over a relatively short period between 4017–3959 BCE and 3974–3900 BCE (68.2%), or between 4172–3947 BCE and 3983–3721 BCE (95.4%). The highest dating probability falls in the narrow range of only 20 years between 3970 BCE and 3950 BCE (Fig. 8). Summarizing the results obtained from trench 1, the backfilling of pit 1 from Trostianchyk took place, with the 'highest' dating probability, during the first half of the 40th century BCE. Considering a more reliable dating range of 68.2% probability, a longer, 200-year use of the site from the middle of the 41st until the end of the 40th century is possible. Other dated contexts from Trostianchyk show, in the case of pit 2 and trench 4, similar narrow dating results falling in the first half of the 40th century […]. In contrast, the highest dating probability of pit 3 and trench 6 might indicate a significantly longer dating range of the settlement between the last decades of the 41st century and about 3800 BCE. However, in the case of the latter two contexts, the quality of the models might be influenced by the fact that in each case only two 14C-dates are available' (Rud *et al.* 2019b, 26–27).

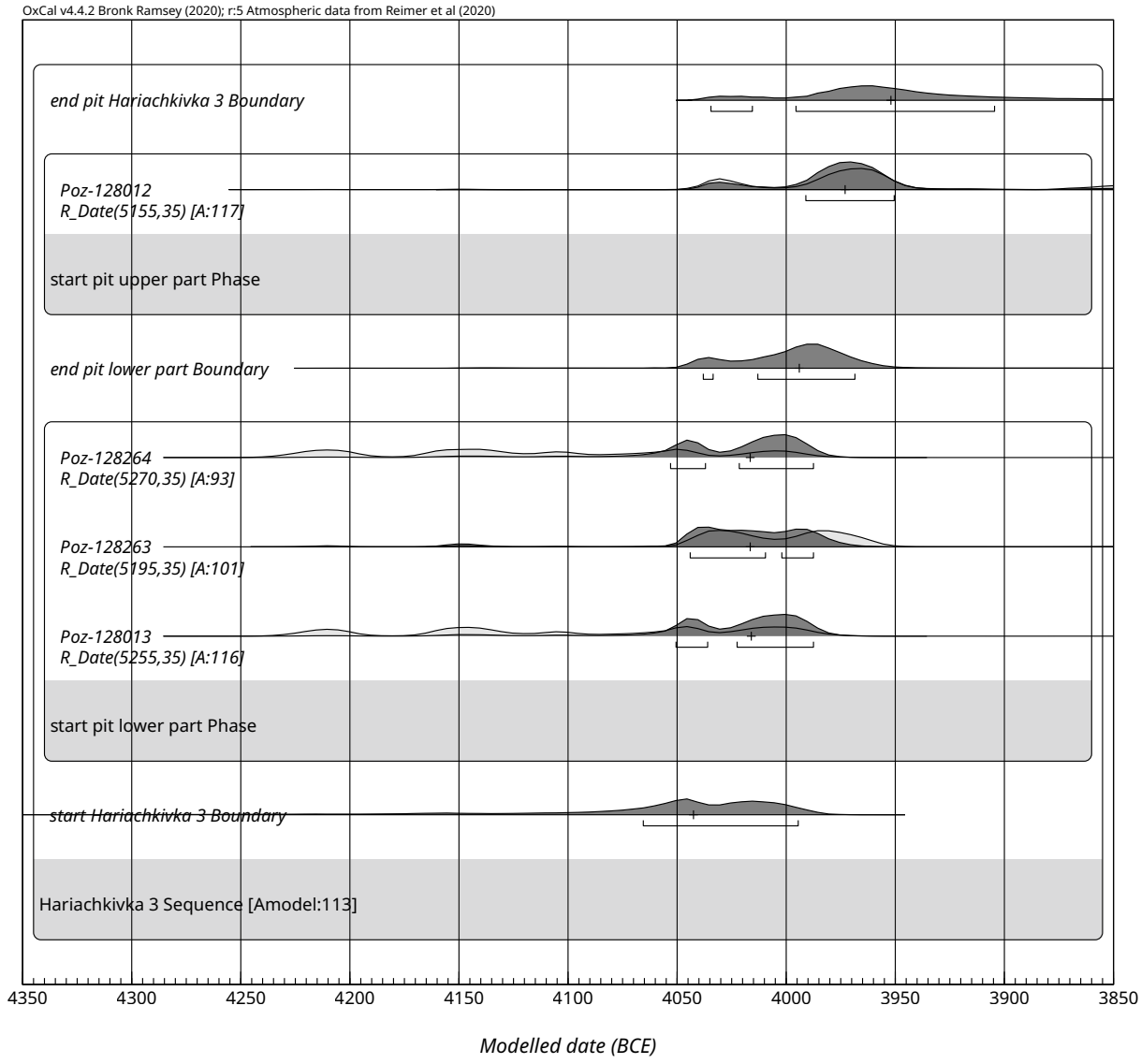


Figure 13. The Bayesian calibrations of Hariachkivka 3 (cf. Suppl. 1–2).

Bilyi Kamin (C1)

The 97-ha site has a trapezoidal layout with a radial orientation of the house rows including huge mega-structures in an open plaza. From Bilyi Kamin, nine bone samples were successfully radiometrically dated in the Poznan and Beta Radiocarbon Laboratories (Suppl. 1–2). The boundaries of the radiometric dating from a stratified pit, one house and an ancient surface near another house confirm a time span of **3950–3690 BCE** (medians; A_{model}=92.1; $A_{overall}$=89.2). Pit 3 with three stratified contexts dates to **3810–3730 BCE**, House 7 to **3890–3820 BCE** and the artefact from the ancient surface, which is probably associated with the use of House 9, to **3875–3690 BCE**. With respect to the dating intervals of the calibration curve, 3960–3780 BCE and 3790–3680 BCE are covered (Fig. 17).

In detail, the following observations and interpretations are valid (Rud *et al.* 2019a, 50–51; Suppl. 2). In Trench 3, three successive stages of the pit filling were dated with the samples Poz-109322, Poz-109323, and Beta-510927. The modelling of these dates resulted in a model with an overall probability of 76.5%, an acceptable range. According to this model, the backfill of the pit took place over a longer period between 3950–3860 BCE and 3849–3785 BCE (68.2%) or between 4032–3810 BCE

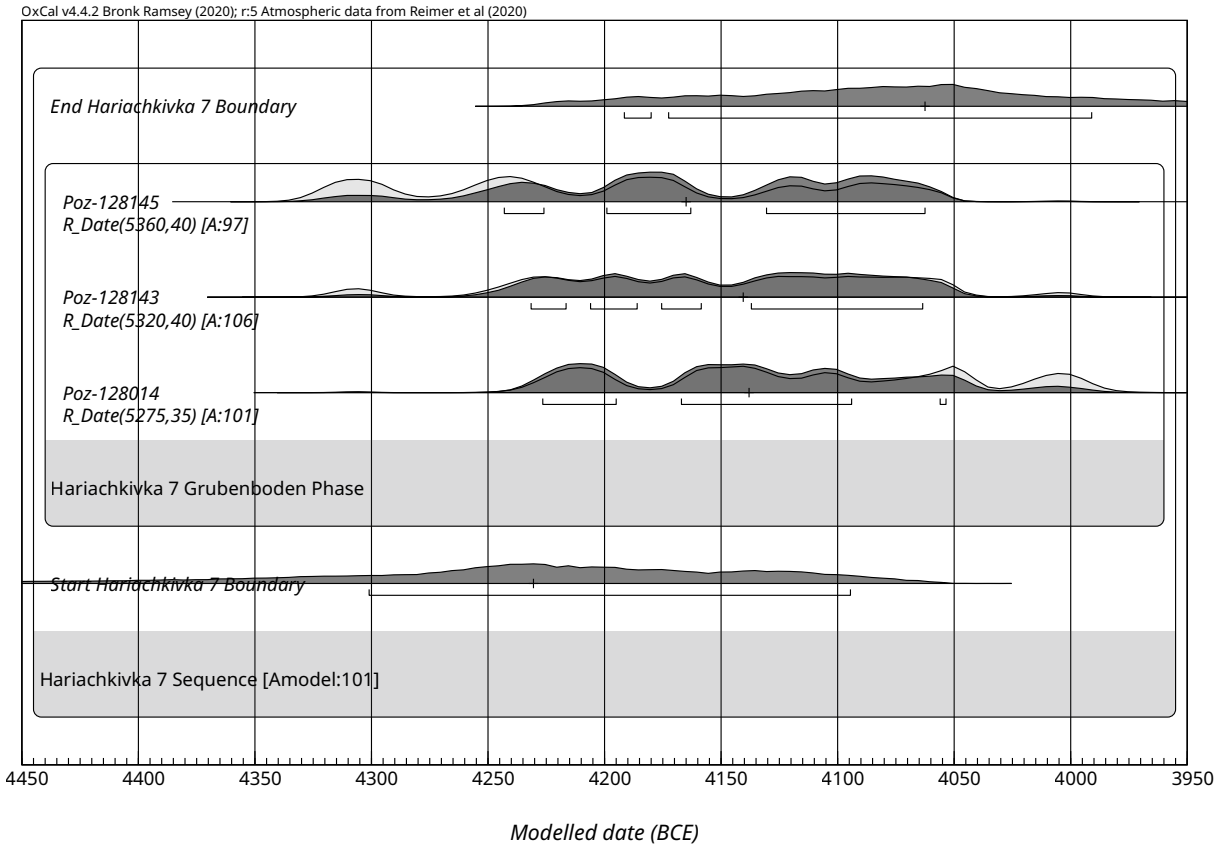


Figure 14. The Bayesian calibrations of Hariachkivka 7 (cf. Suppl. 1–2).

and 3949–3694 BCE (95.4%). The highest dating probability falls within a range of 75 years between 3890 BCE and 3815 BCE.

In Trench 4, the use-time of House 7 was dated with the four dates Poz-109324, Poz-109384, Poz-109450 and Beta-510929. These samples were found in different contexts in the lower and the upper floor of House 7 and the exterior space next to the house. The sample Poz-109378, which was found in the layer above the house debris, probably dates in the time after the use of House 7.

After exclusion of the outlier Beta-510929, the modelling of the dates resulted in the robust model with a probability of A_{model}=102. According to this model, House 7 was used over a period of 0–60 years between 3957–3878 BCE and 3919–3847 BCE (68.2%) or 0–190 years between 4051–3775 BCE and 3935–3781 BCE (95.4%). The post-use phase of House 7 falls in the range between 3919–3847 BCE and 3897–3766 BCE (68.2%) or between 3935–3781 BCE and 3936–3590 BCE. With the highest probability, the use of House 7 took place over a period of 35 years between 3910 BCE and 3875 BCE. The highest probability of the post-house-use activities took place over a period of 25 or 85 years between 3875 BCE and 3850 or 3790 BCE.

In Trench 5, only one sample (Poz-109379) could be successfully dated due to a lack of suitable sample material. The sample originates from a waste disposal area beside the house and probably dates the use of House 9. The sample dates in the range of 3960–3806 BCE (68.2%) or 3968–3798 BCE (95.4%). With the highest probabilities, the sample dates to 3950 BCE or in the period between 3870 BCE and 3820 BCE.

Summarizing the widely consistent results obtained in the different trenches, the settlement activities in Bilyi Kamin took place with the highest dating probability mainly during the 39th century BCE (Fig. 19). Considering a more reliable dating range of 68.2% probability, a 200-year use of the site from the middle of the 40th until the middle of the 38th century BCE is possible. The 2-σ dating range falls between about 4000 BCE and 3600 BCE.

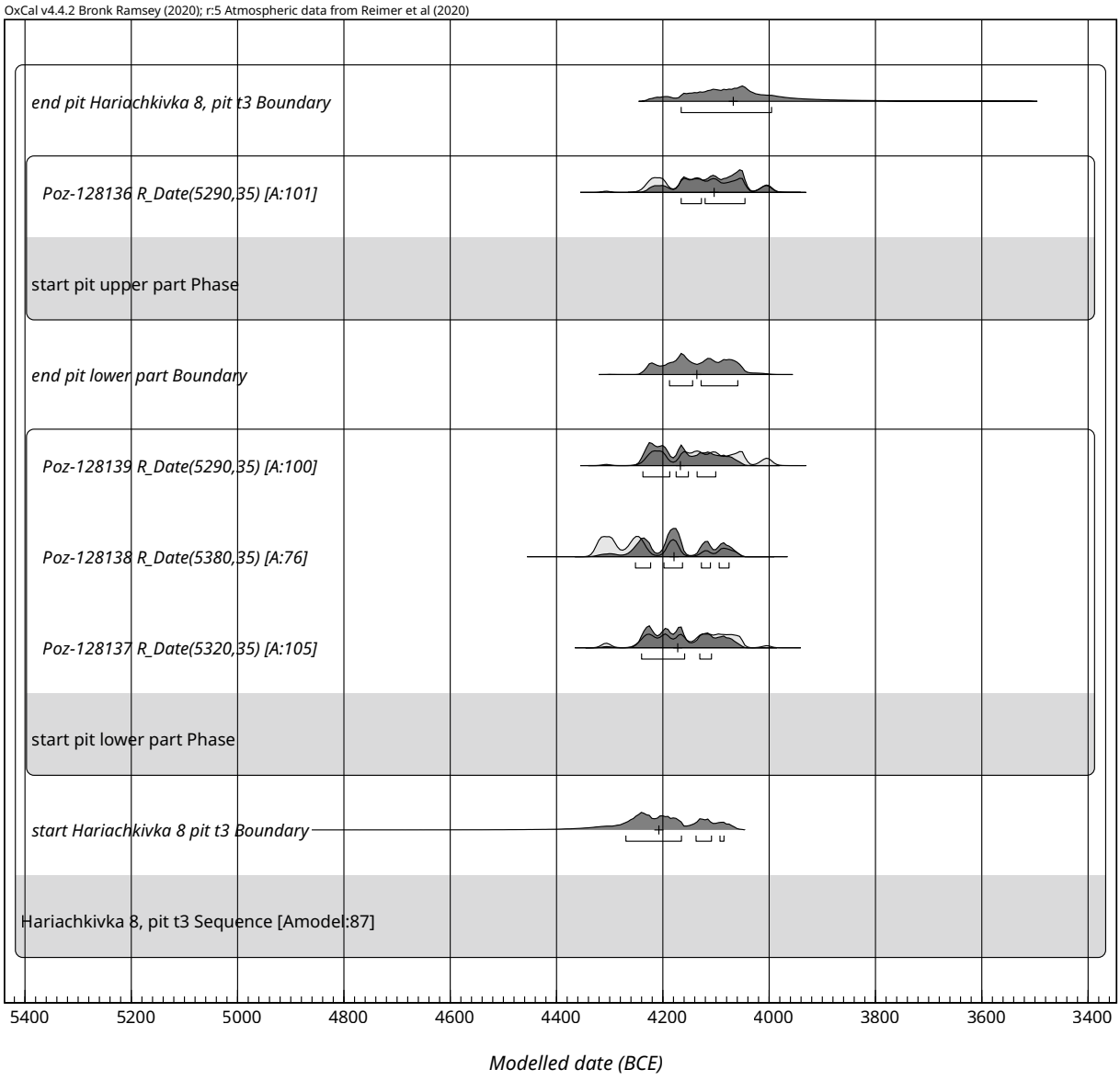


Figure 15 (above). The Bayesian calibrations of Hariachkivka 8, pit 3 (cf. Suppl. 1–2).

Viitivka (C1)

The 48-ha site Viitivka has large oval house rings that form a ring corridor. The geomagnetic survey revealed three mega-structures, more than 60 pits and about 40 burnt houses, likely in at least two concentric rings (Ohlrau 2020, 251, Fig. 157). A test trench of a pit provided six datable samples, which fit into a Bayesian model (Fig. 18). The most probable duration (medians; A_{model}=109.6; $A_{overall}$=110.0) of the pit from **3780–3630 BCE** is also due to 4 pit filling phases, ca. **3780–3750**, **3750–3710**, **3710–3680** and **3680–3640 BCE.** The datings fall within the dating intervals 3790–3720 BCE, 3720–3700 BCE, 3700–3660 BCE and 3660–3640 BCE.

Figure 16. The Bayesian calibrations of Trostianchyk (cf. Suppl. 1–2: Fig. 17). ***Due to the length of this figure, for ease of viewing it is only available online (https://doi.org/10.57892/100-55).***

Krynychky-Ferma (C2)

This site has a circle of houses around a free space and some houses and features outside of this structure, not really linked to the concentric inner principle (Chapter 14, this work, Vol. II). Five radiocarbon samples from test trenches of two pits were suitable. They are linked to the southern part of the inner concentric circle. The overall estimation indicates a duration of the dated pits between **3620 BCE**

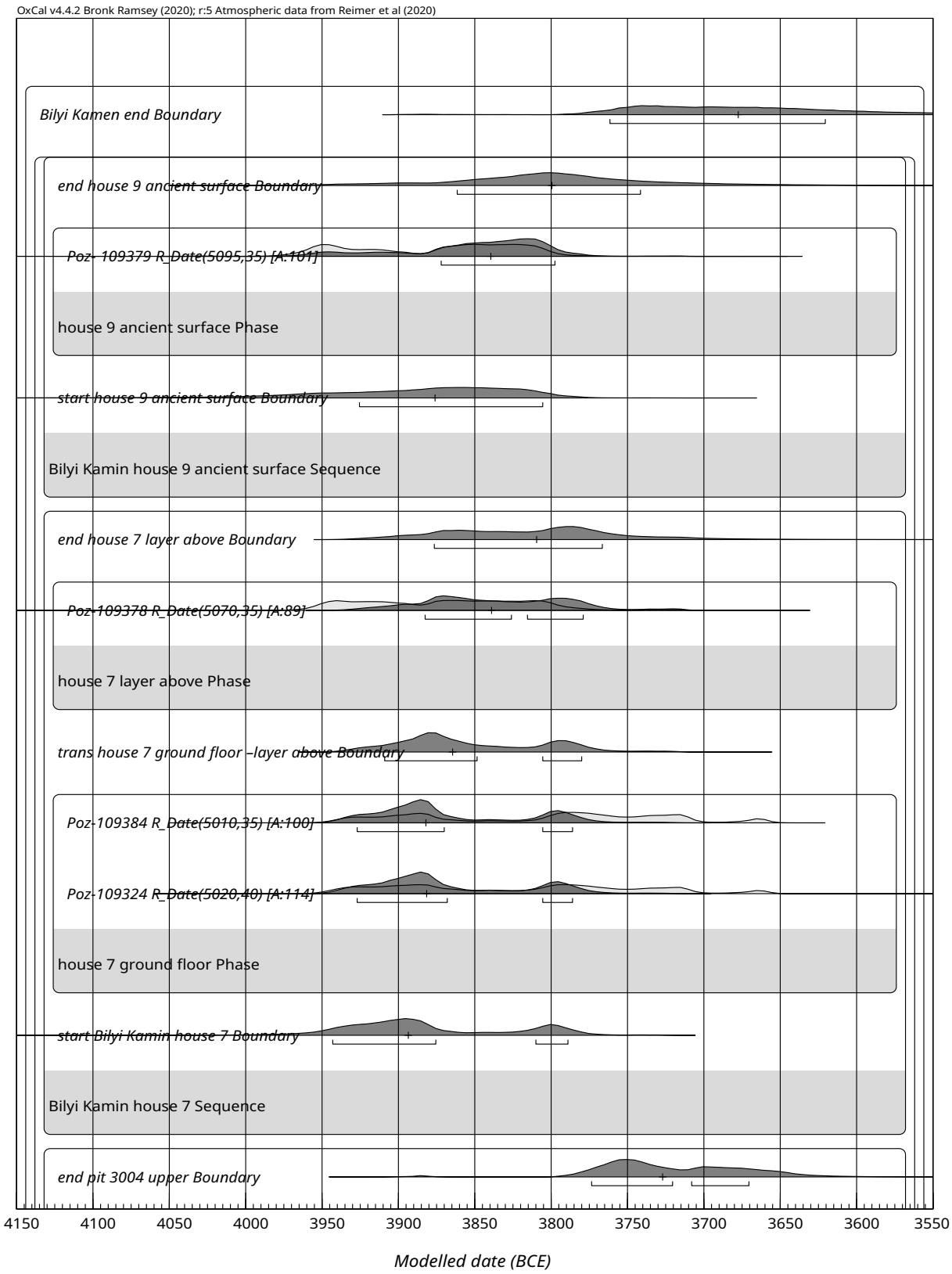


Figure 17A. The Bayesian calibrations of Bilyi Kamin, part 1 (cf. Suppl. 1–2).

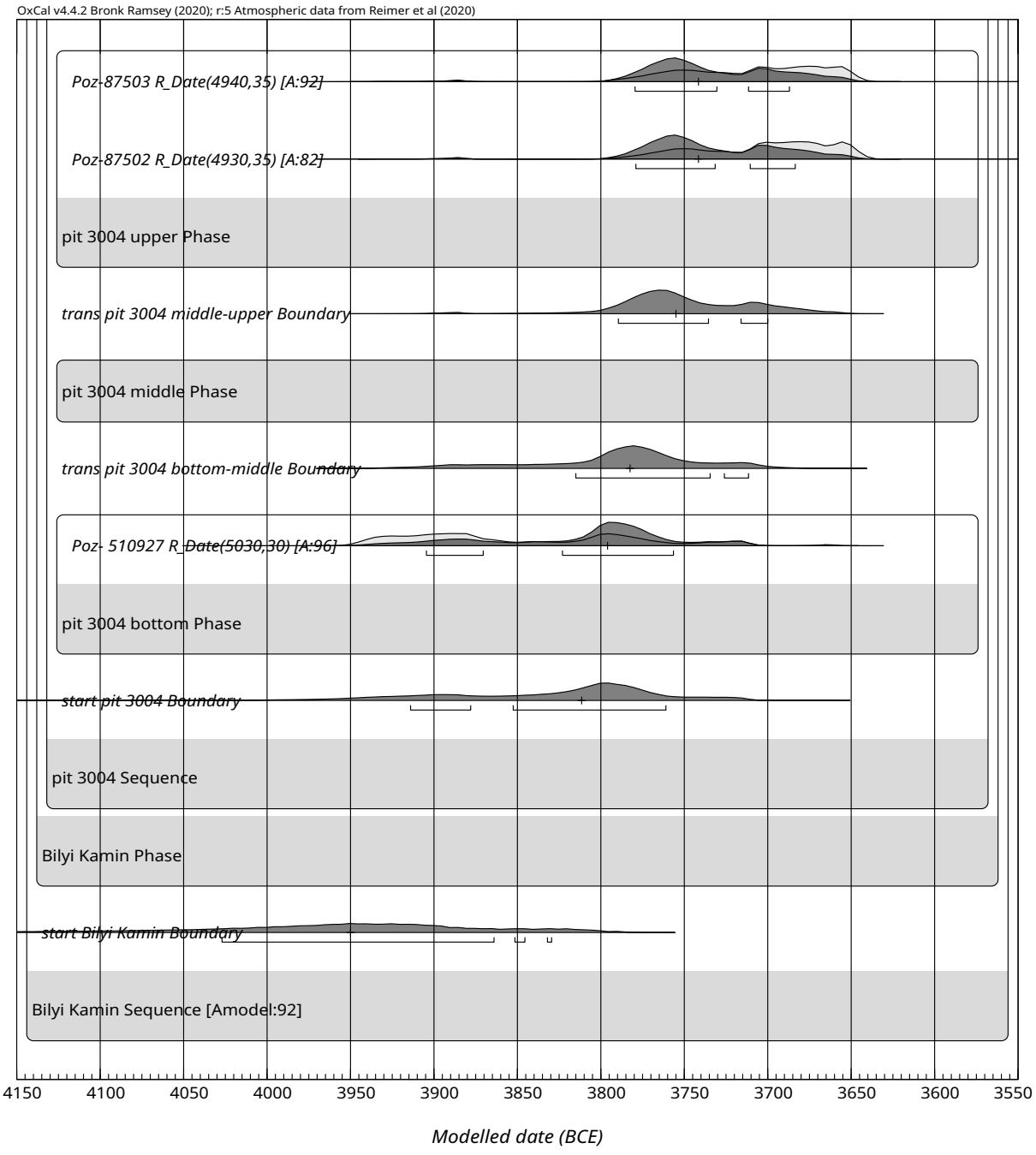


Figure 17B. The Bayesian calibrations of Bilyi Kamin, part 2 (cf. Suppl. 1–2).

and 3530 BCE (medians of the boundaries; A_{model}=102.3; $A_{overall}$=105.2; Fig. 19). If each pit is taken separately, the duration of Pit 1 is estimated from **3580–3560 BCE** and of Pit 2 even from **3580–3550 BCE** (medians of the boundaries). The described deviation is observed because of the dating intervals within the calibration curve (3640–3520, 3520–3380 BCE).

Summary

In the western Trypillia area we estimate Trypillia phases as follows: B1–B2 4270–3970 BCE; B2 3970–3960 BCE; C1 3950–3610 BCE and C2 3620–3520 BCE (Fig. 20).

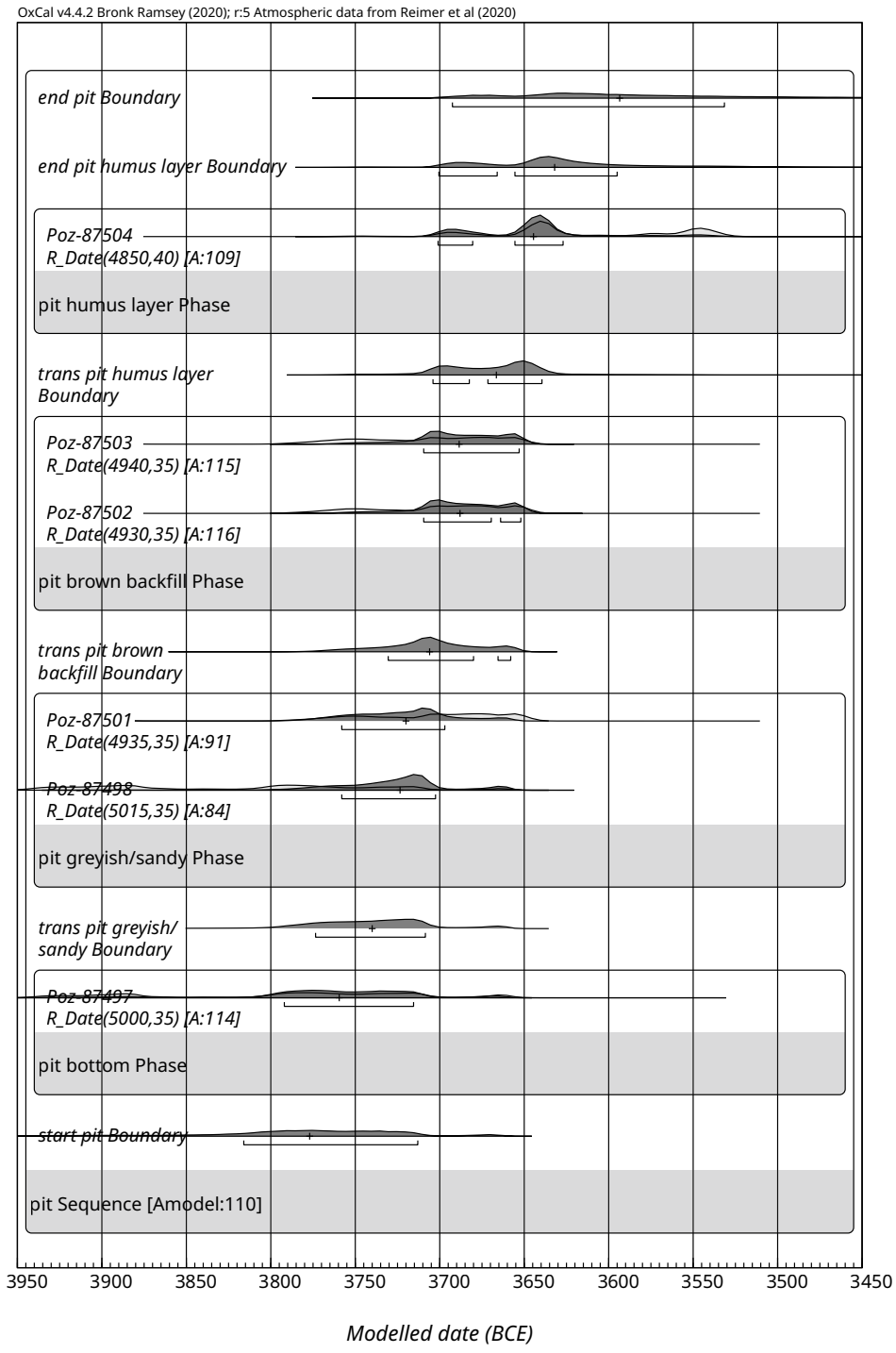


Figure 18. The Bayesian calibrations of Viitivka (cf. Suppl. 1–2).

Southern Bug-Dnieper interfluve (Central Ukraine)

The Dnieper Plateaus between the Dnieper and the Southern Bug form a landscape, in which a cluster of especially large mega-sites is present at the Sinyukha River Basin.

Grebenyukiv Yar (A3)

The 2-ha site has parallel house rows (Shatilo 2021, 149). One pit was dated based on stratigraphic order. Four dates belong to a time span from **4540–4390 BCE** (median; A_{model}=124.5; $A_{overall}$=123.7), belonging to the dating intervals **4550–4460 BCE**

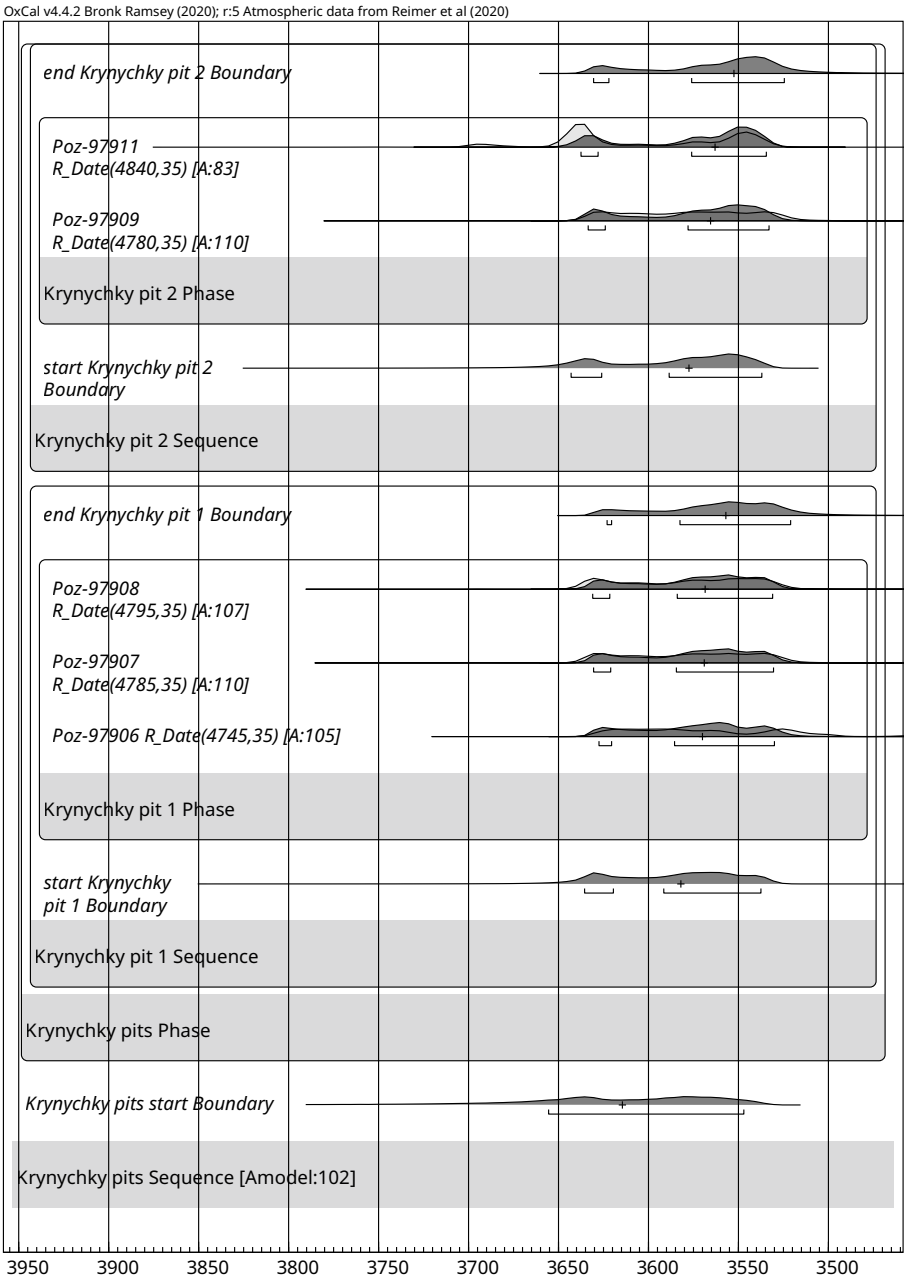


Figure 19. The Bayesian calibrations of Krynychky-Ferma (cf. Suppl. 1–2).

and **4460–4360 BCE**. The lower part of the pit falls into the lower calibration curve plateau, the upper part of the pit into the upper plateau (Fig. 21).

Veselyj Kut (B1–B2)

The 60-ha site with concentric planning, one big and probably five small mega-structures yielded eight datable samples, of which seven fall within the Trypillia range (Shatilo 2021, 146–148). Three of the dates belong to two layers of a pit and five to surface find concentrations at three houses. The date **4150–4000 BCE** (median of boundaries; A_{model}=94.3; $A_{overall}$=95.3) falls within the dating intervals 4230–4050 and 4050–3980 BCE. But in principle, the position on the steep part of the calibration curve at ca. 4050 BCE is plausible. In detail, Pit 1007 with its

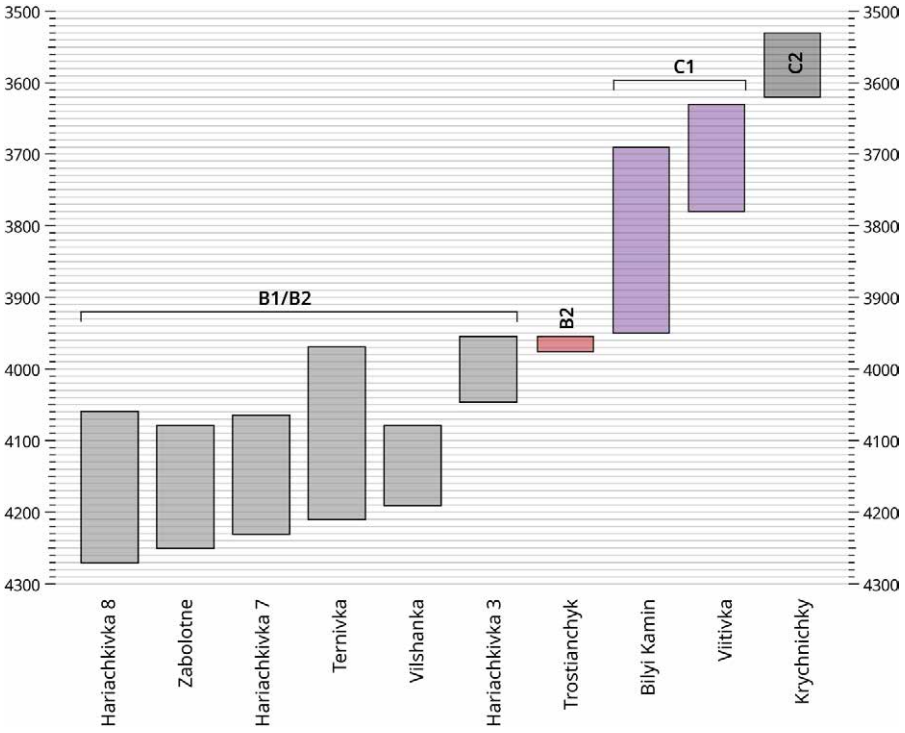
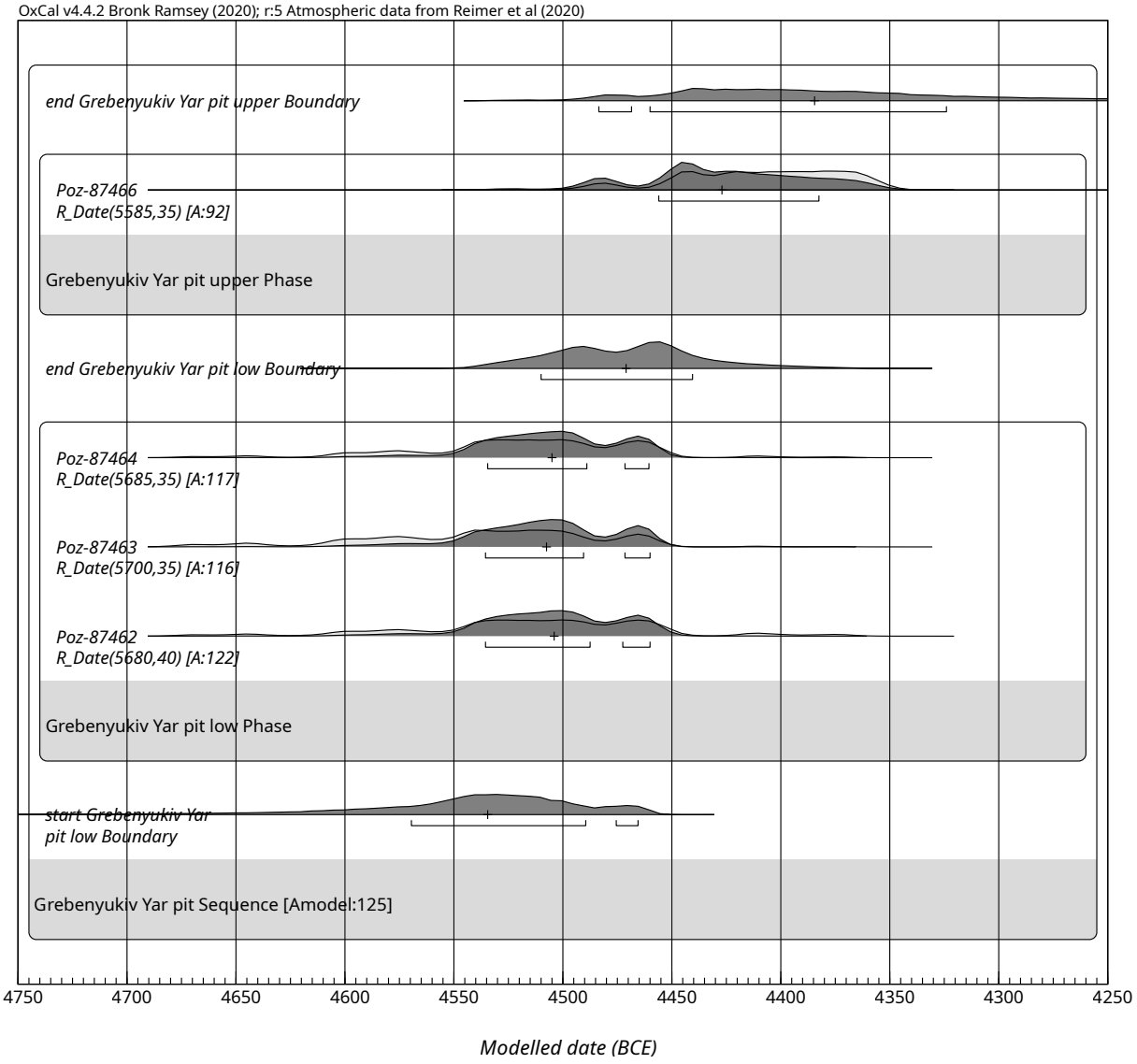


Figure 20. The comparison of Bayesian dates of individual sites from the Bug-Dniester interfluve.

Figure 21 (below). The Bayesian calibrations of Grebenyukiv Yar (cf. Suppl. 1–2).



internal stratigraphic information is dated to 4200–4030 BCE, thus in principle also covering the dating interval 4250–4050 BCE (Fig. 22).

Chyzhivka (B1 or B1/2)

First datings of the 20-ha site with a concentric layout and one central mega-structure belong to a pit, of which two datable samples belong to the period from ca. **4120–3950 BCE** (medians; cf. Suppl. 2: Fig. 2). In principle, the dates are restricted to the dating interval 4050–3980 BCE (Shatilo 2021, 148–149).

Volodymyrivka (B2)

From the 95-ha site with a concentric plan, which includes ten small and one large mega-structure from a test trench, only two samples were datable (Shatilo 2021, 145–146). They belong to two different layers of a pit. The overall dating ranges from **3930–3800 BCE** (medians; cf. Suppl. 2: Fig. 3).

Nebelivka (B2)[7]

With its 235 ha and 1445 verified houses, Nebelivka is relatively large on the one hand, but it has a barely settled inner area on the other hand, and, apart from the ring corridor, it hardly has the otherwise typical concentric house rings (Fig. 23). Due to the extensive research strategy of test pit excavations, many radiometric dates have been produced. They are reanalysed here and in contrast to the original publication, the differentiation between *termini post, ante* and *ad quem* was included into the analyses.

Archive and methods

94 radiometric dates are available from Nebelivka (Millard 2020; Suppl. 3). Due to the status of publications, they can easily be associated with contexts. For instance, the systematic presentation of the layers of the test pits, to which the radiometric samples can be assigned, is exemplary (Gaydarska *et al.* 2020a). In most cases, the find assemblages have not been processed and published. Therefore, it is not possible to associate the dates to the find inventories. However, this does not play a major role here for our questions on the internal development of the site.

Accordingly, we have assigned the dates based on their stratigraphic relationships to the three categories (*post*, *ad*, *ante*). Some specific restrictions can appear with regard to the quality of the samples, for example, reservoir effects of carnivores or old wood effects, such as is common for oak (*Quercus*). This was noted in the ^{14}C list in Supplement 3.

A reduction to *termini ad quem* leads to the reduction of the number of useable ^{14}C dates to 73, whereby the undefined sample material or the possibly problematic material has not yet been sorted out. The dates are more or less evenly spread over the entire settlement area of Nebelivka.

We aimed to determine the basic tendencies of the spatial-chronological distribution of domestic activities in Nebelivka. Thus, the following procedures were chosen:

1. Selection of the *termini ad quem* for the analysis.
2. Calibration of the radiometric data with Oxcal 4.0 according to the Intcal 2020 curve (Bronk Ramsey 2009a; Reimer *et al.* 2020). In addition to the 2-σ probability, the 1- σ probability and the median are calculated.
3. Mapping of the median of the radiometric dates in the settlement plan according to main calibration curve plateaus and slopes of the calibration curve (these

7 The results were partly already published (cf. Müller *et al.* 2022).

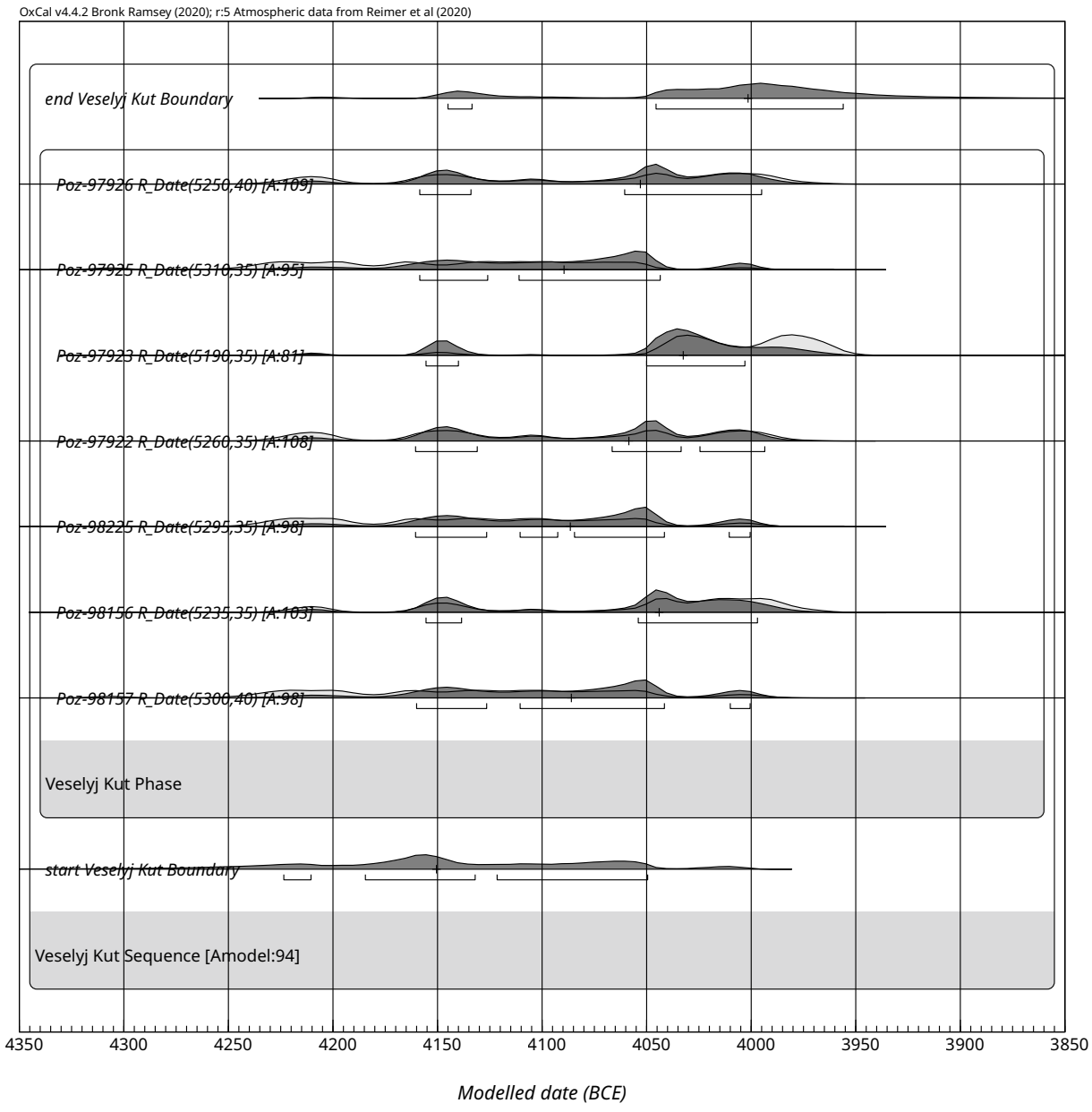


Figure 22. The Bayesian calibrations of Veselyj Kut (cf. Suppl. 1–2).

are: 4050 (–3975) –3950 BCE; 3950–3800 BCE; 3800–3700 BCE; 3700–3630 BCE; 3630–3500 BCE; after 2900–1700 BCE) in order to record the focal points of the respective activities in the respective contexts.

4. Interpretation of the observations. To this end, the main points of distribution are shown graphically and discussed with different parameters (*e.g.* lifespan of houses).

Here, the chosen methodological approach and the resulting analysis are only one component of our analyses. Bayesian dating approaches to contexts, where this is possible, was also applied (see below).

Results and interpretation of mapping ^{14}C dates

The spatial distribution of the medians of the *termini ad quod* dates according to the respective sections of the calibration curve provides a differentiated picture. The similarities and the differences can be described according to a differentiation of external occupancy (outside of the ring corridor), the occupancy of the outer house

row of the ring corridor, of the inner row of the ring corridor and that of the internal settlement (within the ring corridor). Additionally, special spatial and functional units are observed, for example, a kiln or mega-structures[8].

The following outline emerges for spatial and chronological occupation trends at Nebelivka (cf. Tabs. 2–3; Fig. 23):

- From ca. 4050–3950 BCE, the few usable dates indicate occupancy of the outer and inner ring corridors and the inner area.
- From ca. 3950–3800 BCE, settlement of the outer and inner ring corridor as well as the inner area takes place. The large mega-structure is documented. The establishment of houses is twice as common in the inner row of the ring corridor as in the outer row of the ring corridor.
- From ca. 3800–3700 BCE, only the outer row of the ring corridor is still settled, whereas the inner row of the ring corridor is not settled and only one house lies in the inner area at the southern entrance. A smaller mega-structure is documented.
- From ca. 3700–3630 BCE, at a time when hardly any activity is verified, there are two houses in the outer row of the ring corridor that are documented by radiometric dating.

The interpretation of the identified tendencies is simple at first. The oldest house building activities in Nebelivka at ca. 4000 BCE prove that the basic concept of a ring corridor and the inner settlement that does not adhere to concentric rules is known: the few early ^{14}C dates are available from all three areas. After ca. 3950 BCE, the settlement of the inner concentric circles of the ring corridor and the inner area of the mega-site occurs – but also the settlement of the outer circle of the ring corridor. This focus of house building activities changes after 3800 BCE with a new spatial concept: the establishment of new houses is almost exclusively limited to the outer concentric circle of the ring corridor. Even the few house constructions at the end of the occupancy time after ca. 3700 BCE (and before 3600 BCE) are built in the outer circle of the ring corridor.

If we convert the absolute number of dates in the time segments into relative numerical values (per ten years), the high proportion of building activities is particularly clear for the second half of the 40th and during the 39th century BCE. Subsequently, a decrease follows in the 38th century BCE and an end of the activities during the 37th century BCE (Fig. 24).

With these relative dates, we are additionally able to calculate the absolute number of houses in Nebelivka (1445; cf. Hale 2020, 129, Tab. 4.2) with a simple model. First, we assume an average lifespan of 50 years for the houses (cf. Diachenko 2016; Millard 2020, 256; Ohlrau 2020, 233–236). When calculating the number of houses, the respective determined domestic house activities per 50 years were considered, added together, divided by the total number of geophysically determined houses and then finally multiplied again by the relative value per 50 years (cf. formula described above for Stolniceni). According to the results, ca. 75 simultaneously existing houses were calculated for 4000 BCE, ca. 330 for 3875 BCE, ca. 135 for 3750 BCE and 28 for 3675 BCE (Fig. 25).

The graph also presents the variation if assuming an average lifespan of 25 and 75 years for the houses, so that a margin of error can be seen. If we continue to assume that there were 5–10 residents per house, then ca. 375–750 persons lived in Nebelivka around 4000 BCE, ca. 1650–3300 persons around 3875 BCE, ca. 675–1350 persons around 3750 BCE and still 140–280 persons around 3675 BCE (Fig. 25).

---

8 Furthermore, we differentiate more technically radial segments according to the catchment areas of the mega-structures. However, these do not play a role in the further evaluation (cf. Tab. 3).

Interval BCE	Mega-site segments	Outer row of ring corridor	Inner row of ring corridor	Inner area	Others
4050–3950		3	1	1	
	M8		1		
	M17	1			
	M15	1			
	M2	1			
	M6			1	
3950–3800		9	18	6	mega
	M8	1	7		
	M9	2			
	M10	1	1	2	
	M27/3/4		2		
	M13	1	1	2	
	M15	2			
	M2/3	2	3 (pit, big mega)	2	big mega, pit
	M4		3		
	M5		1		
3800–3700		8		1	mega
	M6	1			
	M7	1			
	M8	1			
	M17	1			
	M10/18	1			mega
	M13			1	
	M15	2			
	M2	1	(pit)		pit
3700–3630		2			
	M8	1			
	M10	1			
3630–3500				(indfeat)	Industrial feature
< 2900		1			mega big, mega
	M2/3	1			big mega
	M11				mega
sum		23	19	8	5

Table 2. The number of occupancies in Nebelivka for individual areas of the calibration curve (cf. Suppl. 3).

With regard to the simultaneous houses, the calculated maximum number roughly corresponds to the results of (Millard 2020, 256). Due to the qualitative differentiation of the radiometric dates according to the depositional qualities, it was now also possible to determine the spatial and temporal dynamics of developments at Nebelivka.

Results and interpretation of Bayesian calibration

While we have so far done the single-date calibration and the mapping of the results by time intervals, in the following we will do the Bayesian calibrations of contexts with more than one date and of those with stratigraphy. This was the case

n ^{14}C	Without stratigraphy	Stratigraphy	Single tpq	n
1	32			32
2	2	5		7
3	3	2		5
4	1	1 + MS		2+M
5				0
6		1		1
Single			9	9
Houses n	38	9 + MS	9	56 + MS
Houses directly dated	38	9+MS		47 + MS

Table 3. Nebelivka: the number of ^{14}C dates per context (cf. Suppl. 3).

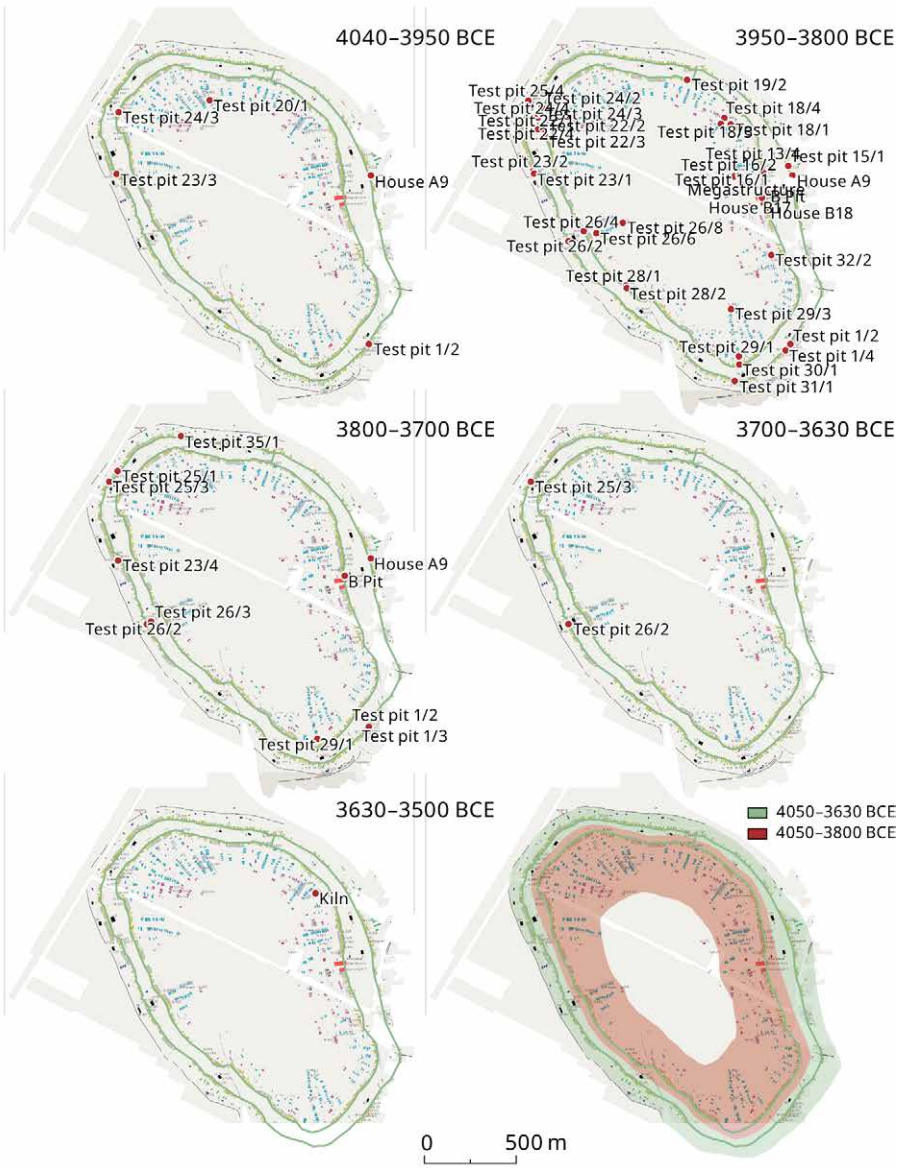


Figure 23. Nebelivka: radiometric dates of termini ad quem *and the settlement model.*

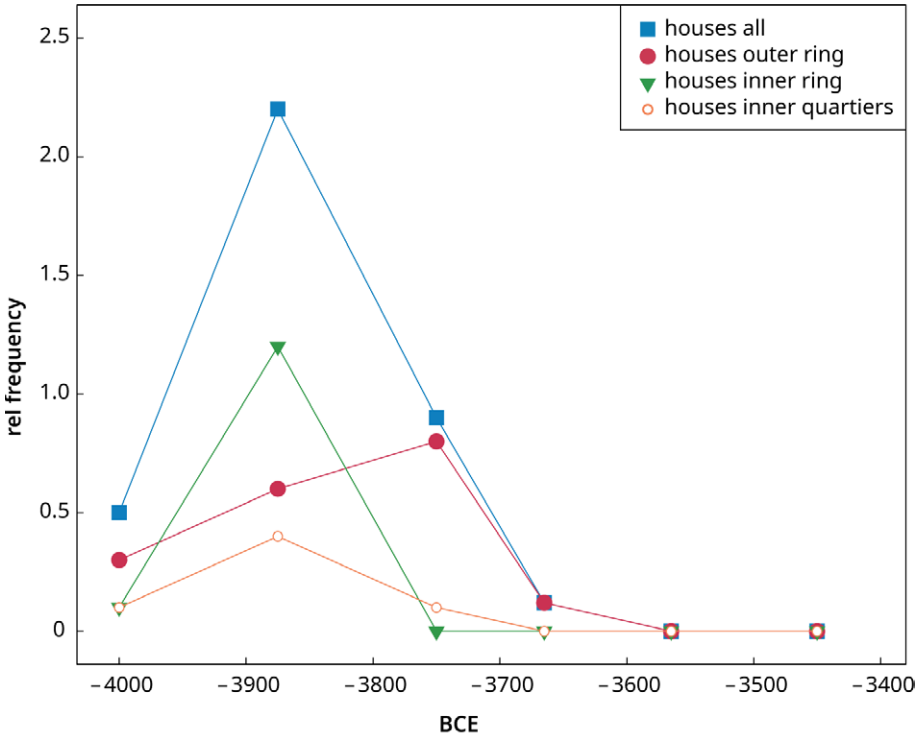


Figure 24. Nebelivka: the relative number of houses (conversion of the dated houses on a linear time scale).

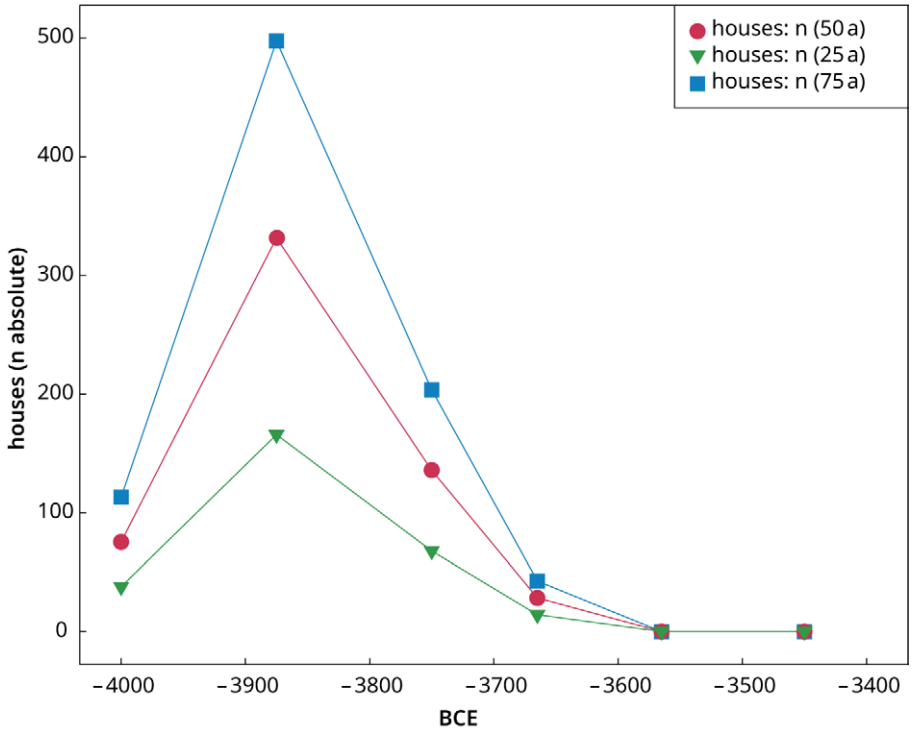


Figure 25. Nebelivka: the absolute number of houses (n) for the assumed use of the houses for 25, 50 and 75 years (a).

at 15 locations, including the test trenches, two of the excavated houses and the large mega-structure (Tab. 3)[9]. In detail, the following results of Bayesian dating of contexts with few ^{14}C dates are valid (cf. Suppl. 2):

House A9. Three dates, with unclear stratigraphic relationship to each other, represent the phase of use. The Bayesian calibrated duration by median values ranges from **3935–3795 BCE** (A_{model}=112.9; $A_{overall}$=112.3; Suppl. 2: Fig. 4).

House B17 (Videiko and Burdo 2020). Based on the data, it is assumed that OxA-29667 (depth data 56 cm) was found below the *ploshadka* (up to 30 cm deep). The assignment of OxA-29600 (K6 H11) is not possible and the bone specimen not specified. The Bayesian calibrated duration by median value is set to **3962–3775 BCE** (pure ^{14}C data range: 3949–3866 BCE (limits) with medians 3866 and 3872 BCE; A_{model}=103.3; $A_{overall}$=103.5).

House B18. One date is available (K6), probably of the use of the house (3960–3800 BCE, median 3865 BCE).

Mega-structure (Gaydarska *et al.* 2020b, 194–211). Only three dates are available: OxA-31745 associated with the 'mega 2 construction phase' (bone species not identified); the two other dates from the 'mega 3 use time' are older, but in the model this does not play a direct role (Suppl. 2: Fig. 5): The Bayesian calibrated duration by median values is set to **3923–3823 BCE** overall, of the use phase **3869–3823 BCE**, and of the construction phase **3923–3869 BCE** (A_{model}=107.8; $A_{overall}$=106.2).

House Test Pit 1/2. The structure provides two dates of one sample (OxA-29576, OxA-29577) in Context 3, which in combination date the house use to **3931–3713 (median 3793) BCE**. A further date is stratigraphically unclear.

House Test Pit 13/4. The date OxA-29664 belongs to the upper layer and probably characterises a phase of use, whereas OxA 29346 comes from Layer 5 and is a *terminus post quem* (albeit oak with possible old wood effect). Nevertheless, the Bayesian model (A_{model}=102.8 / $A_{overall}$=103.2) is conclusive (Fig. 26). The Bayesian calibrated duration of the use of the house by median values ranges from **3786–3678 BCE** (A_{model}=102.8; $A_{overall}$=103.2).

House Test Pit 16/2. This house provides two dates (OxA-29347, OxA-29348) of one sample in Context 3, which, if combined, provide an estimate of house use from **3949–3805 (median 3863) BCE**.

House Test Pit 22/2. The date OxA 29592 belongs to the upper layer and probably characterises a phase of use. OxA 29666 derives from Layer 5 and is a *terminus post quem*. The Bayesian model is conclusive (A_{model}=100.4 / $A_{overall}$=100.3; Fig. 27). The Bayesian calibrated duration of the use of the house by median values is set to **3882–3813 BCE**.

House Test Pit 24/2. The structure provides three dates in Context 3 (OxA-31635, OxA-31636, OxA-31637), which together result in a conclusive Bayesian model (A_{model}=98.6; $A_{overall}$=100.1). The Bayesian calibrated duration of the use of the house by median values is set to **3935–3810 BCE**.

House Test Pit 24/3. The date Poz 72470 belongs to the lower layer of use (burnt clay), OxA 31638 and OxA-31639 are from Context 3 and represent the house use. The Bayesian model is conclusive (A_{model}=114.4 / $A_{overall}$=112.5; Fig. 28). The Bayesian calibrated duration of the use of the house by median values is set to **4038–3852 BCE**. The exceptional much older date was dated at the Poznan lab.

House Test Pit 25/3. The house provides three dates from Context 4 (OxA-31642, OxA-31663 (these two originate from one sample) and Poz-72471), which together result in a conclusive Bayesian model (A_{model}=93.5 / $A_{overall}$=95.3). The Bayesian

9 Data-quality: From the Houses B17, 18/4, 19/2, 19/4, 20/1, 22/3, 23/4, 25/4, 27/4, 28/2, 31/1, and 35/1, there are only data available which were obtained from problematic sample material (bone not determined, pig, *Quercus*).

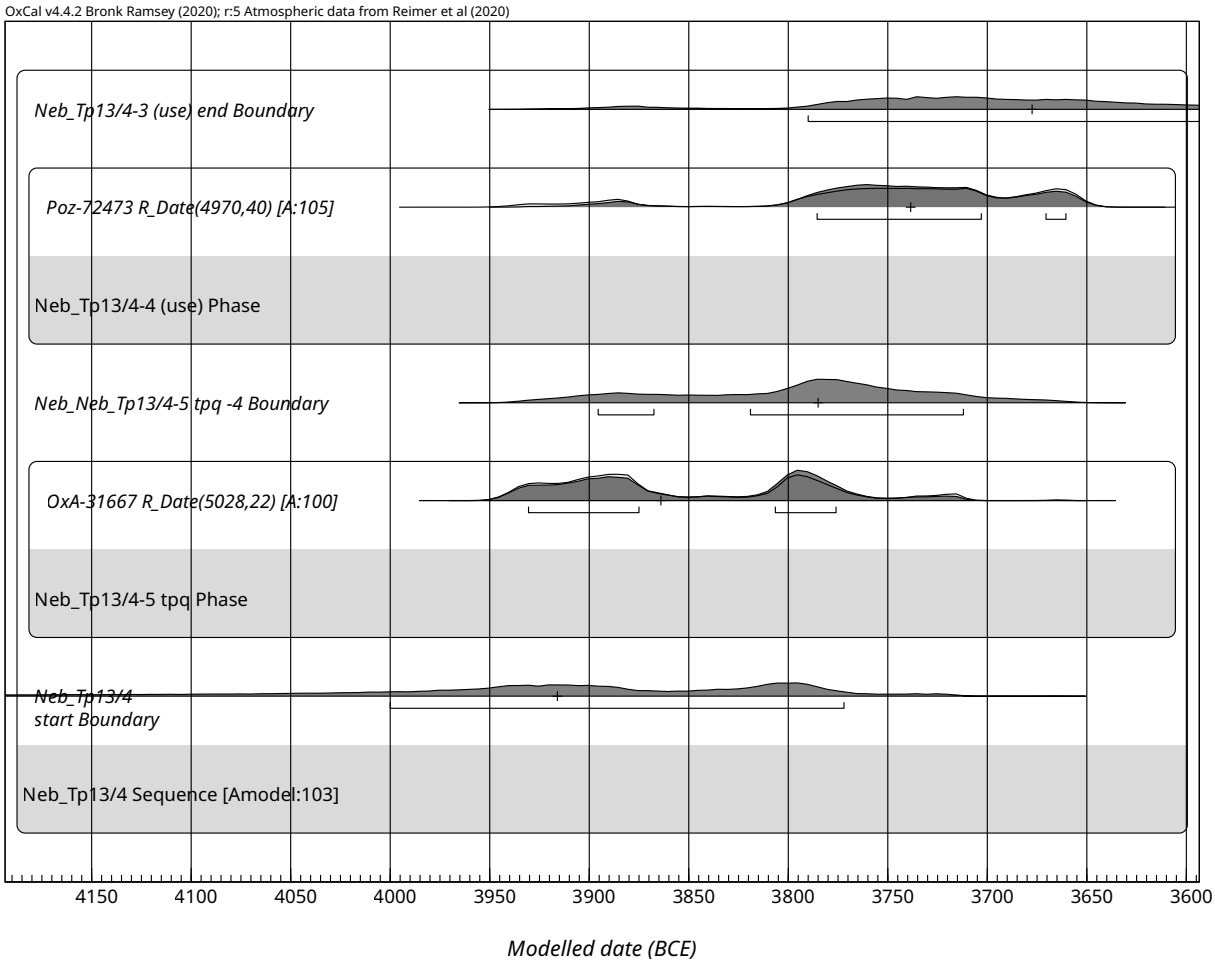


Figure 26. The Bayesian calibrations of Nebelivka House 13/4 (cf. Suppl. 1–3).

calibrated duration of the use of the house by median values is set to **3789–3634 (median 3712) BCE** (Suppl. 2: Fig. 7).

House Test Pit 25/1. There are two dates. OxA-31664 belongs to the upper layer and probably characterises a phase of use, but this is a pig bone. OxA-31665 derives from Context 5 and is a *terminus ante quem*. Nevertheless, the Bayesian model (A_{model}=100.6; $A_{overall}$=100.6) is conclusive. The Bayesian calibrated duration of the use of the house by median values ranges from **3881–3815 BCE**.

House Test Pit 26/2. Three dates are associated with two phases of house use. Bayesian dating does not lead to a useful model, because the stratigraphically older phase has the youngest date Poz-72472 (poor agreement: A_{model}=51.4; $A_{overall}$=51.8). Without this Poznan date, the model is conclusive (A_{model}=106.4 / $A_{overall}$=105). Thus, the Bayesian calibrated duration of the use of the house by median values is set to **3906–3731 BCE** (Suppl. 2: Fig. 8).

House Test Pit 26/3. Two dates with a good fit represent a *terminus ante quem* and use-phase. Thus, the Bayesian calibrated duration of the use of the house by median values ranges from **3786–3678 BCE**.

House Test Pit 26/4. Four data form a conclusive Bayesian model (A_{model}=104.6 / $A_{overall}$=106.6). The Bayesian calibrated duration of the use of the house by median values is set to **3893–3846 BCE**, of the tpq from 3931–3893 BCE (Suppl. 2: Fig. 9).

House Test Pit 30/1. With the two data, a conclusive Bayesian model is provided. The Bayesian calibrated duration of the use of the house by median values ranges from **3864–3814 BCE**.

House Test Pit 29/4. Six data are provided, of which 2 are re-measurements (combine function in use). Activities obviously took place after the house duration

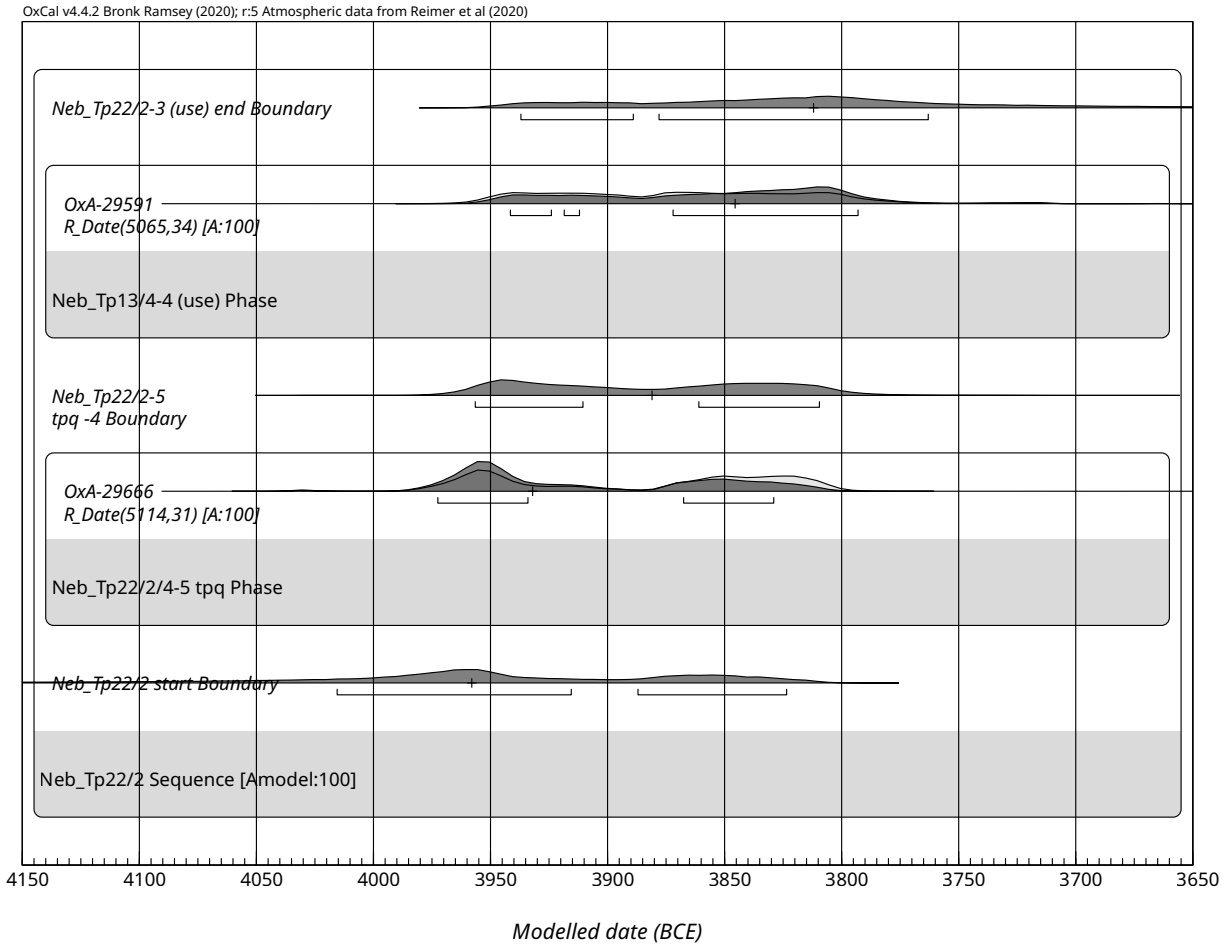


Figure 27. The Bayesian calibrations of Nebelivka House 22/2 (cf. Suppl. 1–3).

(Layer 1) and during 2 phases of use (Layers 3–4). The Bayesian calibrated duration of the use of the house by median values is set to **3922–3858 BCE** (A_{model}=87; $A_{overall}$=92.6; Fig. 29).

In principle, the results do not deviate from those presented via the mapping of individual radiocarbon data (see above). In this respect, if considering the *termini post quem* and *ante quem* for the sharpening of the time intervals of the 15 houses, the obtained results confirm the basic tendency of the development of the Nebelivka site.

Furthermore, it can be stated that the 14 tpq-dates – 11 probable domesticated animals in addition to two indeterminate bones and one oak sample – belong to the time interval ca. 3950–3800 BCE. Thus, if these samples also indicate the use of domestic sites, the modelling of occupation density would be even more concentrated in the time period before 3800 BCE (Fig. 30). The medians of the boundaries place the main occupation from ca. **3920–3825 BCE** (A_{model}=81.9; $A_{overall}$=67.2).

Nebelivka: Overall results and interpretation – the *organisation of house generations*

A detailed spatial examination of the *termini ad quem* in individual areas of the settlement confirms the already proposed model.

In the settlement, the ^{14}C dates cluster spatially in specific areas (Fig. 31). In all areas, an older house is found (Phase 1: 4050–3950 BCE), followed by an occupation of the rows in the following Phase 2 (3950–3800) and a further occupation in Phase 3 (3800–3700 BCE). For example, in the NW with Test Pit 24/3, we recognise a house of Phase 1, which is followed by 6 dated houses in the inner ring corridor ring and one in the outer ring corridor ring in Phase 2. In the outer ring, the

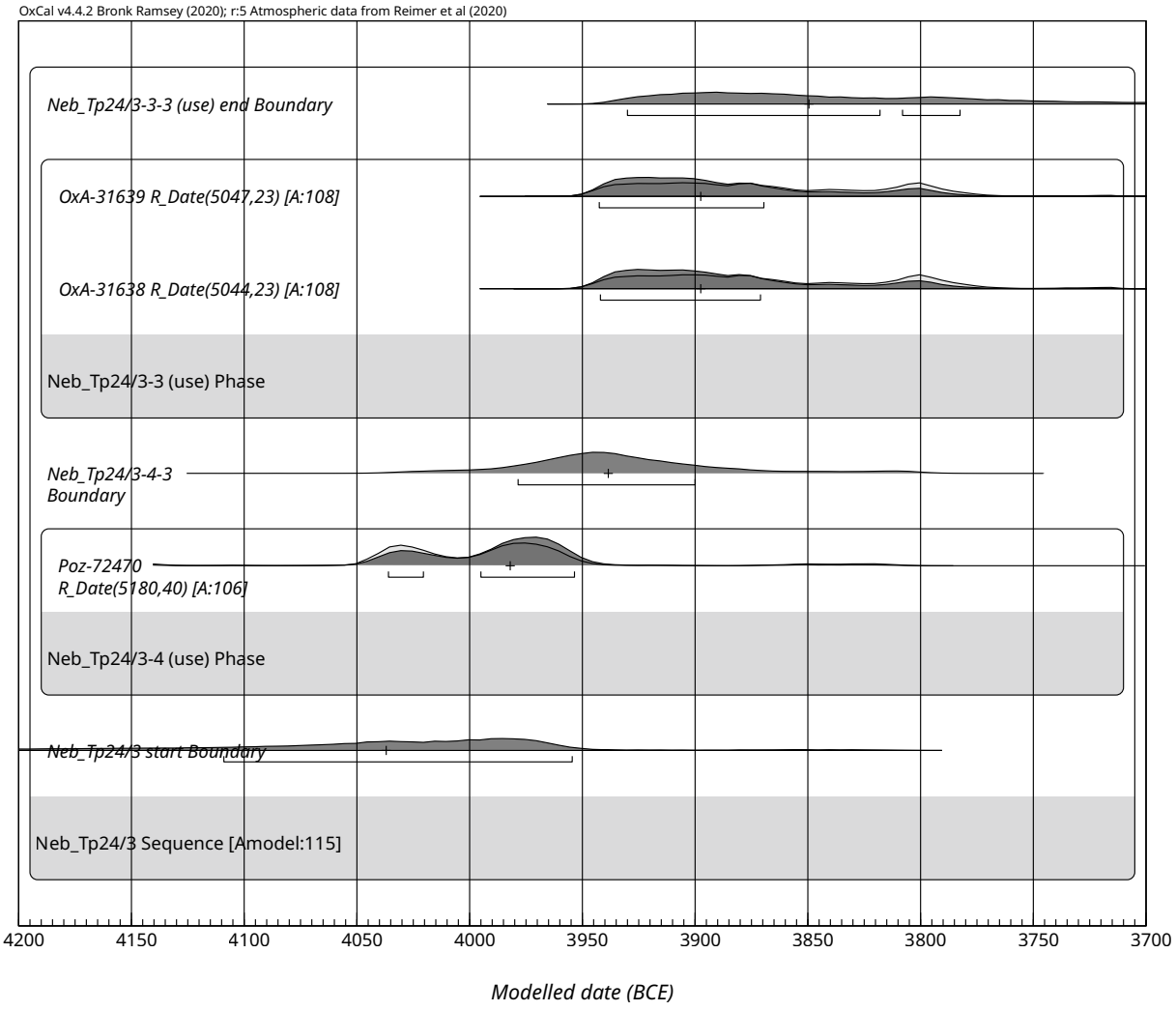


Figure 28. The Bayesian calibrations of Nebelivka House 24/3 (cf. Suppl. 1–3).

houses Test Pit 25/3 and Test Pit 25/1 are the last new foundations in Phase 3 (ca. 3800–3700 BCE). In a comparable form, this pattern is repeated (but without new houses in Phase 3) in the NE, in the area of the mega-structure, and in the west. In the south, we find all three house foundation phases represented, even with closely neighbouring houses in the outer ring.

As far as the dated mega-structures are concerned, the large and the directly neighbouring mega-structure House 17 are contemporaneous in Phase 2 (3950–3800 BCE), the smaller Mega-structure 23/3 is younger (Phase 3: 3800–3700 BCE).

With this detailed information and the possibility to describe the internal spatial occupation process, Nebelivka will be generally comparable with other mega-sites.

Pishchana (B2, early C1)

The 15–16 ha large site (Shatilo 2021, 143–144; assemblages not published) yielded seven datable samples from test trenches, of which one did not fit the final model (Fig. 32). Five used dates belong to two houses and one to a pit. While the overall estimation links the data to the time span **4010–3900 BCE** (medians of the boundaries; A_{model}=121.1; $A_{overall}$=122.1), the two houses did probably exist between **3960–3930 BCE** and **3980–3950 BCE**, while the pit, which is associated with the first house, had a duration from **3980–3960 BCE**. The data covers the dating intervals 4040–3980, 3980–3950 and 3950–3890 BCE, but is mainly restricted to the

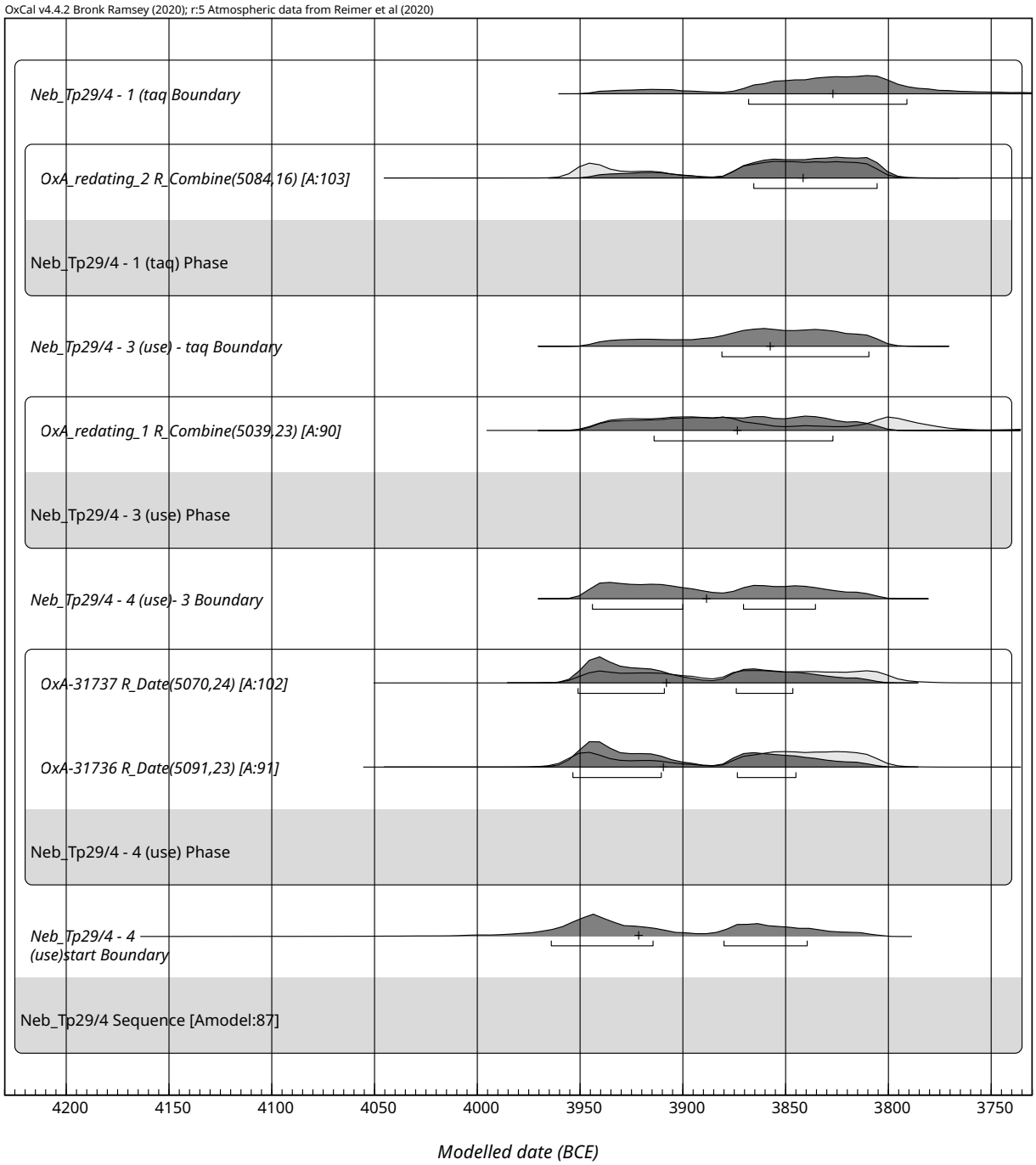


Figure 29. The Bayesian calibrations of Nebelivka House 29/4 (cf. Suppl. 1–3).

Figure 30. The Bayesian calibrations of Nebelivka, all features (cf. Suppl. 1–3, including Suppl. 2: Fig. 6). ***Due to the length of this figure, for ease of viewing it is only available online (https://doi.org/10.57892/100-55).***

first two dating intervals. In principle, the steep part of the calibration curve is mostly covered (3980–3950 BCE).

Rohy (B2–C1)

Rohy is a site measuring 5.3 ha and is composed of mainly two concentric house rings and an empty inner space (Ohlrau 2020, 244–245). The excavation of a test pit revealed three samples for ^{14}C dating (Chapter 13, this work, Vol. I). According to medians, the pit was filled during the time span **3710–3530 BCE** (Suppl. 2: Fig. 10; A_{model}=114.7; $A_{overall}$=113.9).

Dobrovody (C1)

The 100-ha mega-site yielded radiometric data from a mega-structure and a kiln (Shatilo 2021, 141–142). Of the six suitable dates, five are used in the general model since a date from the Kiel lab did not fit into the model (Fig. 33). Altogether, the site is dated between **3820 BCE and 3720 BCE**, with the kiln **from 3790–3760 BCE** and the mega-structure **from 3790–3760 BCE** (medians; A_{model}=112.3; $A_{overall}$=113.2). The individual Bayesian modelling of the kiln displays a duration from **3830–3700 BCE** and the mega-structure from **3890–3720 BCE.**

The dates cover the data intervals 3940–3780 and 3780–3720 BCE. Nevertheless, most of the data is restricted to the steep part of the calibration curve at 3790 BCE.

Moshuriv 1 (C1)

From the 1-ha site that consists of two house rings and houses also in the central area, three datable samples belonging to one pit were analysed (Ohlrau 2020, 241–243, Fig. 149; Shatilo 2021, 144–145). In principle, the pit is dated from **3940–3630 BCE** with two dates in the dating interval 3790–3660 BCE and one in the dating interval 3960–3790 BCE (Suppl. 2: Fig. 11; A_{model}=94; $A_{overall}$=93.4).

Moshuriv 2 (Smaglievi Berehy) (C1)

The plan of the site is difficult to explain: a kind of outer house ring seems to be visible (Ohlrau 2020, 244–247, Fig. 152; Chapter 13, this work, Vol. I). Radiocarbon dates from a pit confirmed a date around **3935–3625 BCE**.

Maidanetske (C1)

Encompassing 200 ha in size and numerous excavation activities, Maidanetske is one of the very well-researched Trypillia mega-sites (Müller *et al.* 2017; Ohlrau 2020; Figs. 34–43). The number of houses could be reconstructed to 2932 (Ohlrau 2020, 64, Tab. 7). Even if there are more than 90 radiometric datings available for Maidanetske at the moment, the detailed analysis is quite difficult. This is true because of the wiggle and plateau structure of the calibration curve. In principle, we observe a steep dating interval from ca. 3990–3950 BCE, followed by a dating interval with a wiggle plateau from 3950–3780 BCE, another dating interval from 3780–3730 BCE including a plateau, a further dating interval from 3730–3640 BCE including a positive and a negative steep part, and a dating interval with a steep part from 3640–3550 BCE. As such, the dating evidence depends very much on the security of the dates and internal stratigraphy within the different contexts. Due to the quantity of ^{14}C dates, individual Bayesian dating for single contexts is possible as well as a mapping of the results, with which the internal development of the mega-site can be roughly reconstructed.

Results and interpretation of mapping ^{14}C dates

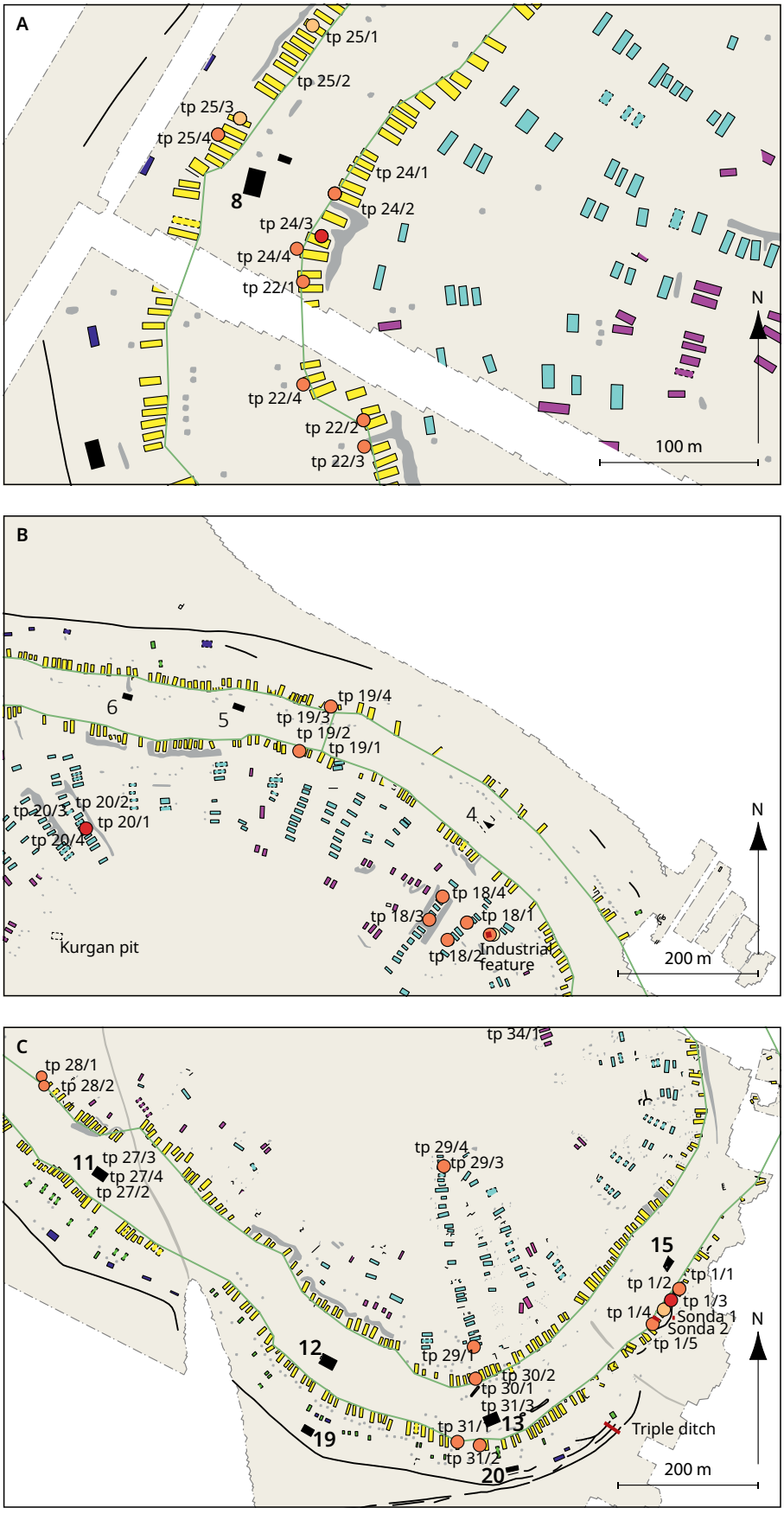
Method and spatial arrangement of the site

Of the 85 dates from Maidanetske[10], most can be identified as *termini ad quem* and only a few as *termini ante quem* or *post quem*[11]. In the following, we will first look at the data according to the wiggle areas individually in terms of their contexts

10 In addition to the new AMS dates, among the data there is a conventional date from the Berlin laboratory from undetermined charcoal, which came from the south-west of the site (Bln-2087). This is not included in the analysis.

11 Poz-97625 from the topsoil and Poz-60196 from geotrench 70 are to be noted as *termini ante quem* for the settlement activities, whereas Poz-60298 from trench 72 is regarded as a *terminus post quem*.

Figure 31A–F. Nebelivka: chronology of different districts (cf. Suppl. 1–3).



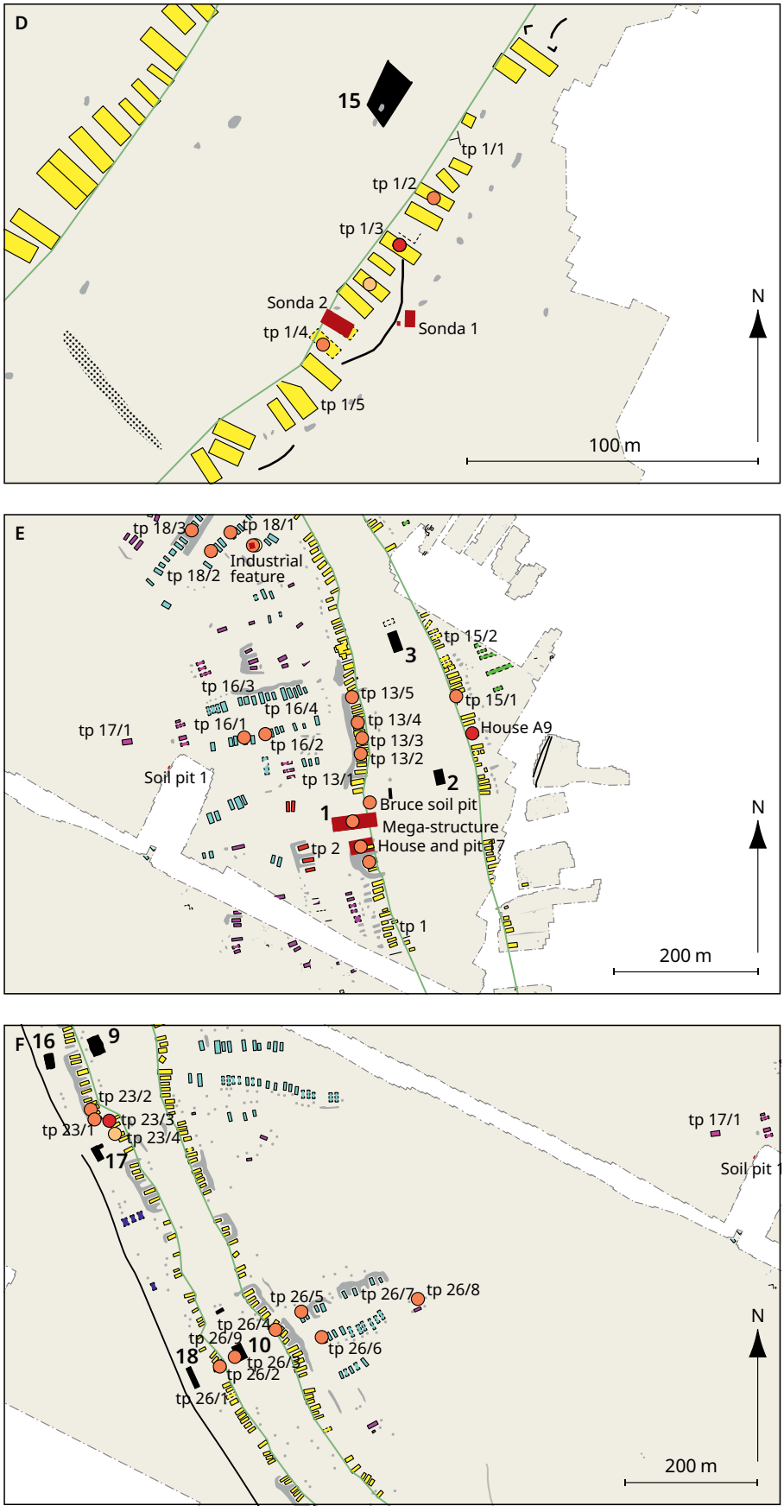


Figure 31A–F, continued.

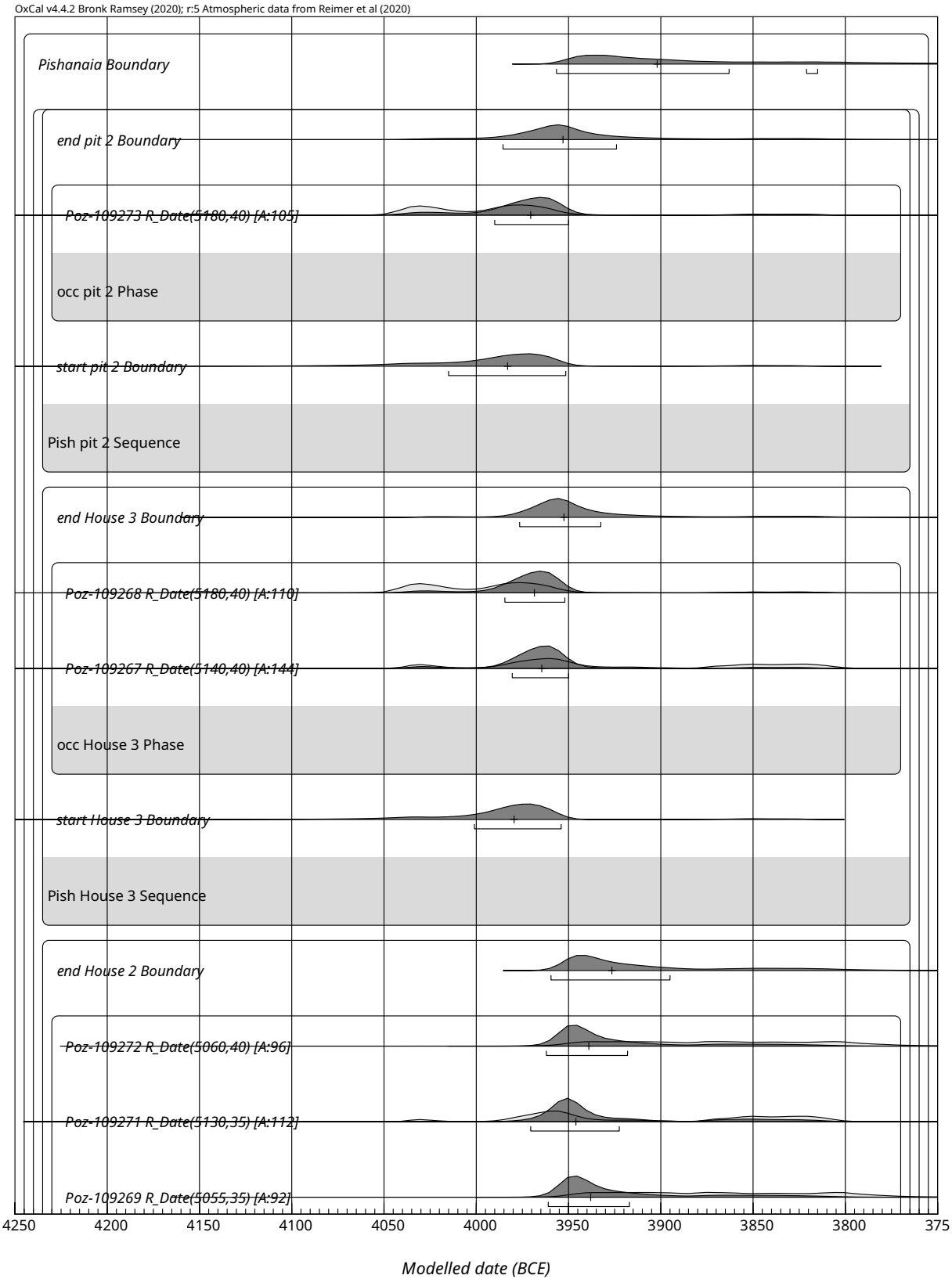


Figure 32. The Bayesian calibrations of Pishchana (cf. Suppl. 1–2).

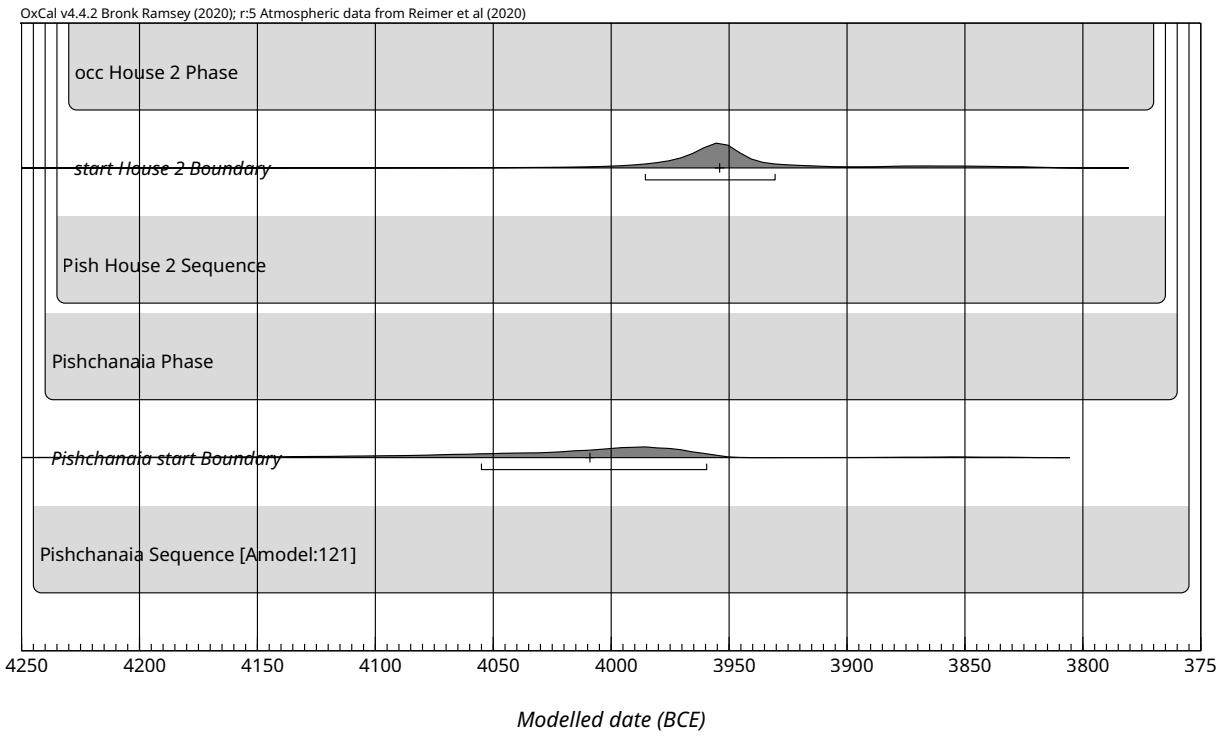


Figure 32, continued.

and spatial distribution in the settlement plan (for the detailed method cf. previous section of this chapter on Nebelivka).

With the excavation strategy of main and special trenches, large areas of the entire settlement were recorded, but due to the accessibility of the site, the excavation trenches concentrate on a south-south-western and north-north-eastern area designated here as 'SSW' and 'NNE'. In the SSW area, at least 9 concentric rows of houses could be identified (Fig. 34; Müller *et al.* 2016a, 135, Fig. 1), in the north-east also numerous rows of houses (Fig. 35). Here the situation is more complex due to the second or third Maidanetske settlement (house rows 1–3) and the radial settlement structure with houses having a gable orientation parallel to radial entrances. In addition, some of the concentric house rows are not continuously laid out and are correspondingly difficult to differentiate over long distances. Accordingly, we differentiate 14 rows of houses, whose numbering, except for the rows of the ring corridor (4–5), does not have to correspond to the numbering of the rows of houses in the SSW.

It also makes sense to divide the entire settlement into certain overlapping spatial units (from outside to inside) due to the empty central square, the ring corridor and Trenches 1 and 2: Outer Area 1 outside Ditch 1, Outer Area 2 between Ditch 1 and Ditch 2, Outer Area 3 between Ditch 2 and the ring corridor, the ring corridor, Inner Area 1 with the rows of houses and quarters following the ring corridor, and Inner Area 2 at the inner boundary of the settlement (Tab. 4; Fig. 35). With this information, a description of the development in Maidanetske is possible.

Maidanetske Phase 4000–3800 BCE

The two formally oldest dates are from the wiggle section at ca. 4050–3950 BCE (Fig. 36). There is a date from Pit 26 of House 44 of SSW Row 1 (Trench 52) in the SSW, and a date from the potter's kiln (Trench 80) in the NE. If we add early dates with a median older than ca. 3900 BCE, we find another date from the filling of the western ditch in the NNE (Poz-87561), another from Pit 26 of House 44 (SSW Row 1, Poz-60347, though oak), one from the oldest backfill phase of Pit 25 (Trench 50) of the outer ring corridor, *i.e.* SSW Row 4 (Poz-60189). From this distribution of data, René Ohlrau (2020, 226–227, Fig. 143) concluded that the settlement begins with

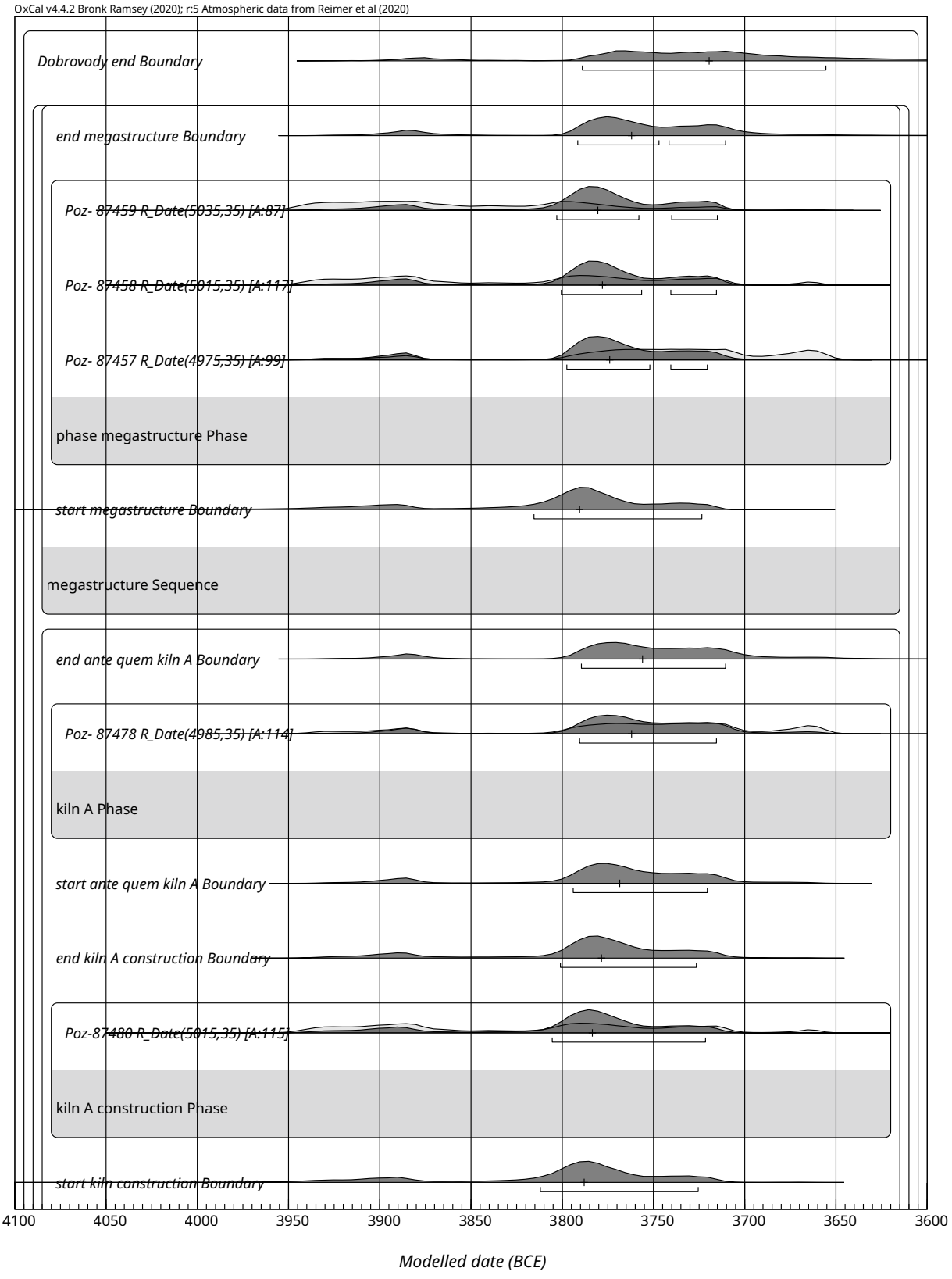


Figure 33. The Bayesian calibrations of Dobrovody (cf. Suppl. 1–2).

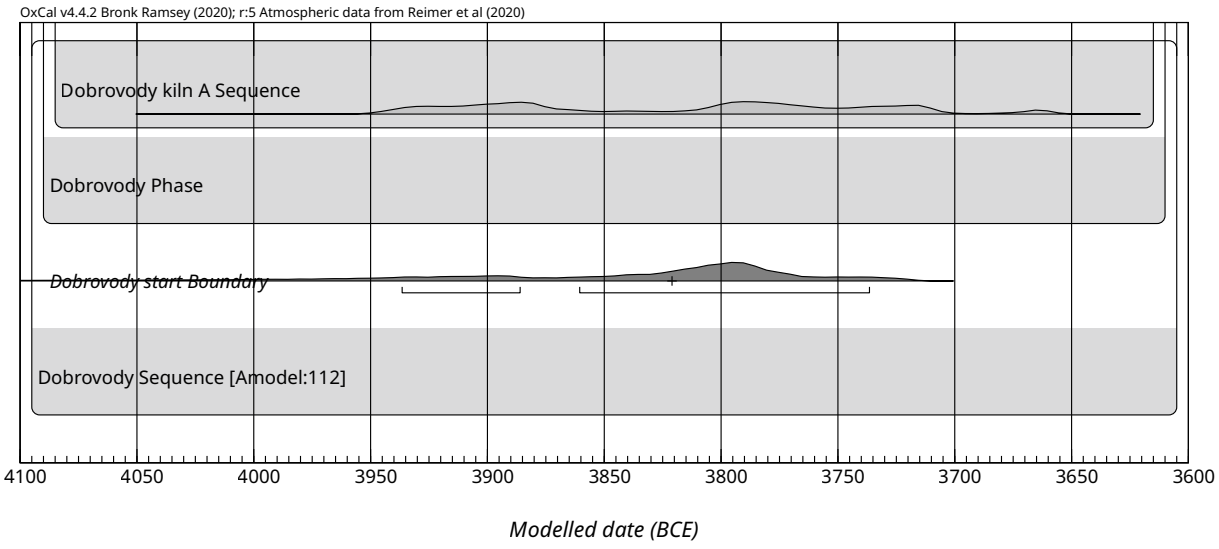


Figure 33, continued.

the marking of the enclosure and the establishment of the infrastructure (kiln). In addition, the dating of the pit infills from SSW House Rows 1 and 4 probably also shows that the settlement of Maidanetske had already been occupied at this time.

Apart from the early dates (>3900 BCE), if we consider the entire period 3950–3800 BCE, there are 34 dates from 14 features at nine localities spread over wide areas of the settlement. In a spatial view from the exterior to the interior of the settlement, data from the western and eastern ditch segments of Ditch 1 and from Pit 32 from the same trench are among the most spatially outwardly located activity evidence. This could indicate that Outer Area 1 and 2 were not occupied at least until ca. 3700 BCE.[12]

The dates of Pit 26, which belong to House 44 of SSW House Row 1, originate from the Outer Area 3 between Ditch 1 and the ring corridor. We also know a date from House 44 that directly dates the use of the house.

The data of Pit 25 (belonging to House 12) already belongs to the ring corridor, namely to the outer house row (SSW House Row 4). The excavated Mega-structure 3 is located in the ring corridor. The use of the mega-structure is documented with three dates. The data comes from the waste of the wall construction. Pit 33, located next to Mega-structure 3, also dates to the period mentioned here. We can therefore assume an intensive use of the mega-structure. Pit 27 (SSW Row 5) can possibly be counted as part of the inner house ring of the ring corridor. However, it is located on the inner side of SSW Row 5 and could already belong to the Inner Area 1, just because of its special functionality. Here, an open square measuring approx. 30 m in diameter, framed by pits, emerges, which lies between the outer ring corridor row (SSW Row 5) and SSW House Row 6.

This Inner Area 1 includes dates from Pits 28, 29 and 30 associated with the excavated pottery kiln and those directly from Houses 54 and 60. Pit 30 and House 60 belong to NNE House Row 12, with House 54 (NNE Row 11). The aforementioned houses are located on two radial paths that lead into the feature-free inner square. Pits 28, 29 and 30 (partly containing waste from pottery production) are located – also similar to the situation described at the ring corridor – in a square again about 30 m in diameter, which again seems to have specific functions. This is the area where the kiln infrastructure already existed early on.

12 However, Pit 32, which is located directly in the eastern segment of the ditch, is assigned to House 67 by René Ohlrau (2020, 228, Fig. 144). House 67 is located in the NNE House row 2 outside Ditch 1 and thus already in Area 2.



Figure 34. Maidanetske: dating of the 9 house rows in the SSW area (according to Müller et al. *2016a, 135, Fig. 1).*

In summary, we realise that Maidanetske becomes the focus of planning activities probably from ca. 3970 BCE (median earliest data). By ca. 3900 BCE, approximately two generations had laid down the basic concept, at least for the settlement areas of the areas enclosed by Ditch 1, and the first houses were built in the Outer Area 3. The innermost settled area of the entire settlement (Inner Area 2) is obviously not yet settled.

Maidanetske Phase 3800–3700 BCE

For the period 3800–3700 BCE, 30 dates are available from 19 features. All areas of the large settlement are recorded (Fig. 36A and B).

Spatially farthest out in *Outer Area 1* is a dating from House 64. Possibly a new settlement attempt was made in the north. For the NNE Section 101 with House 64, a row of houses is documented which we do not necessarily associate with Maidanestke 1. The orientation points to differently oriented settlement activity in the north of the main settlement.

Further inside, House 67 was occupied in the *Outer Area 2* of the actual NNW House Row 2 near the eastern ditch segment. There are also 5 dates from this house. From the Outer Area 3, we know dates from House 44 (SSW House Row 1) and the associated Pit 26, from the *ring corridor* those of Mega-structure 3 with associated pits and Pit 25 belonging to House 12. Again, there are dates from Pit 27, which may have to be connected with the inner house row of the ring corridor. Data from Houses 60, 61 and 62, and also from the potter's kiln, are verified for Inner Area 1, those from Houses 52 (SSW House ring 8), 53 (SSW House ring 9), 57 (NNE House Row 14), 58 (NNE House Row 13) and 59 (House Row 14) from the *Inner Area 2*.

Thus, with the Outer Areas 1 and 2 and the Inner Area 2, new areas of Maidanetske are settled, which were not previously covered by ^{14}C dating. Compared to all other phases, the largest spatial expansion of settlement activities is realised.

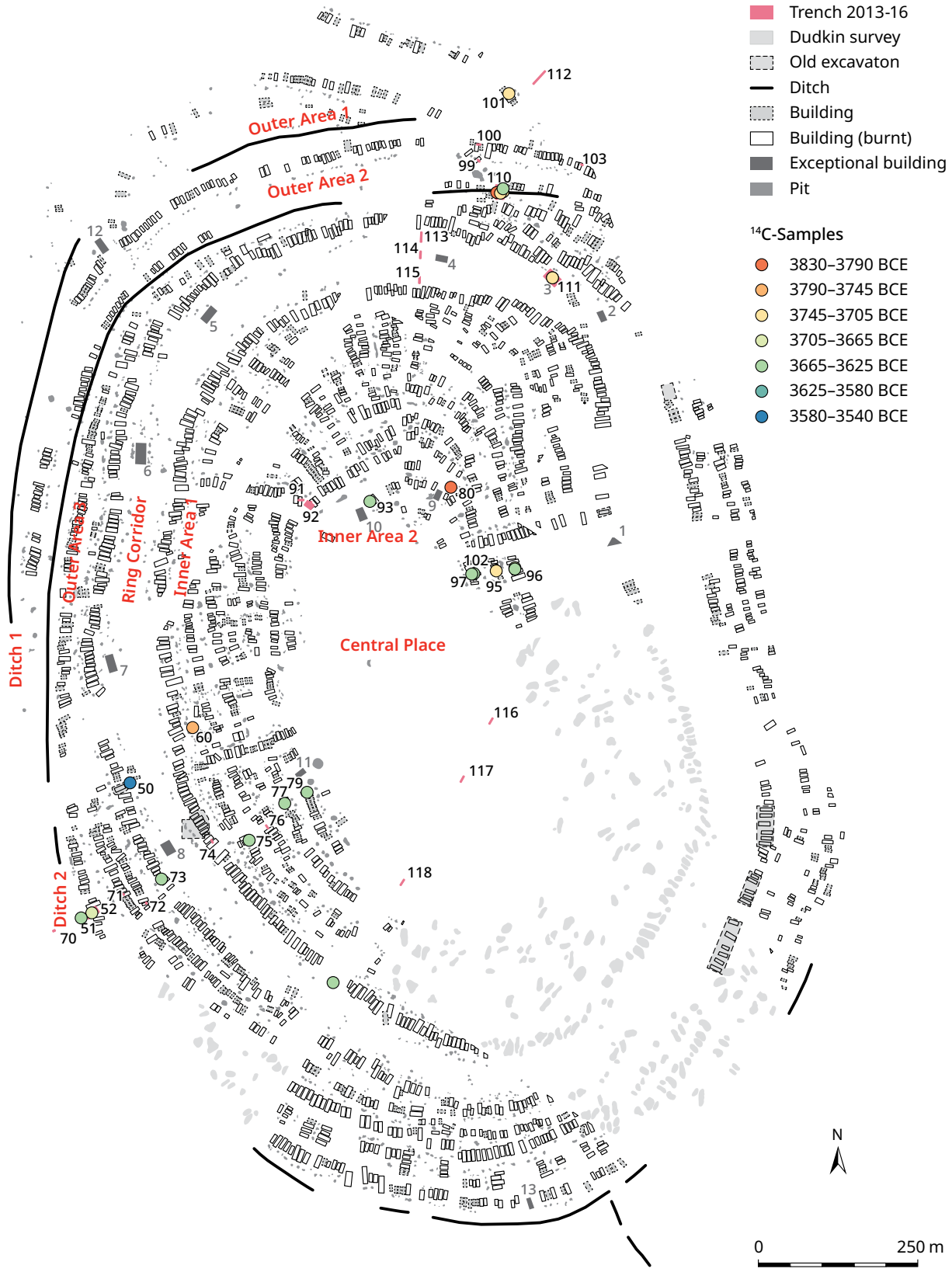


Figure 35. Maidanetske: general plan and distribution of radiometric dates (cf. Suppl. 1–2).

Interval BCE	Mega-site segments	Outer area 1 (to ditch 1)	Outer area 2 (between ditch 1 and 2)	Ditch 2	Outer area 3 (between ditch 2 and ring-corridor)	Ring-corridor		Inner area 1 (between ring-corridor and inner rings)	Inner area 2 (inner rows 13/14, 9/8)	Pottery kiln
						Outer	Inner			
4050–3950	Mai				1					1
	S80 (kiln ph3)									1
	Pit 26 (tr52 (H44)				1					
3950–3800				5	3	7	4	13		
3950–3900	W ditch			1						
	Pit 25 (tr50 H12)					1				
	Pit 26 (tr52 H44)				1					
3900–3800	W ditch			1						
	E ditch			2						
	Pit 32 (tr110 H67)			1						
	Pit 26 (tr52 H44)				1					
	H44 (tr51)				1					
	Pit 25 (tr50 H12)					2				
	Mega 3 (tr 111)					3				
	Pit 33 (tr111)					1				
	Pit 27 (tr60)						4			
	H60 (tr95)							1		
	Pit 30 (tr 80 kiln ph 3)							2		
	Pit 29 (tr 80 kiln ph 1)							4		
	H54 (tr92)							5		
	Pit 28 (tr 80 kiln ph 1)							1		
3800–3700		1	1	5	2	8	2	5	6	
	H64 (tr101)	1								
	H67 (tr110)		1							
	Editch			5						
	H44 (tr51)				1					
	Pit26 (H44, tr52)				1					
	Mega 3 (tr 111)					3				
	Pit34 (tr111/2) 1					1				
	Pit35 /pit(tr111/3)					2				
	Pit25 (tr50 H12)					2				
	Pit27 (tr60)						2			
	H62 (tr96)							1		
	H61 (tr96)							2		
	Kiln end							1		
	H57 (tr93)								1	
	H58 (tr93)								2	
	H52 (tr77)								1	
	H60 (tr95)							1		
	H59 (tr94/102)								1	
	H53 (tr79)								1	
3700–3630			1	2	1	2			1	
	H67(tr110)		1							
	Editch			2						
	Pit26 (H44, tr52)				1					
	H47/48 /tr 73)					1				
	HZh					1				
	Tr79 ts								1	
Sum		1	2	12	7	17	6	18	7	1

Table 4. The number of occupancies in Maidanetske for individual areas of the calibration curve (cf. Suppl. 2).

Maidanetske Phase 3700–3630 BCE
The seven dates from the 3700–3630 BCE curve segment are spatially scattered over the entire area of the large settlement, but direct *termini ad quem* are only represented between Ditch 2 and the ring corridor (Fig. 37). These are two dates from the eastern ditch segment, from Pit 26 southwest of House 44 (Trench 52) of SSW House Row 1 and those to the outer row of the ring corridor with House 47/48 and House E (SSW House Row 4). The dates for House 67 (NNE House Row 2) and for Mega-structure 3 are probably *termini ante quem*, as is the case with a date from trench 79. Obviously, therefore, only minor activities can still be detected at Ditch 2 and the outer ring corridor, while Mega-structure 3, for example, is no longer in use.

Maidanetske Phase 3630–3500 BCE
The dates with a median of 3630–3500 BCE are from the topsoil (Poz-60352), soil organic residue (Poz-60198) and from an upper pit fill (Poz-60175; Fig. 37). Among the six even younger dates, Poz-60351 and Poz-60160 are from stratigraphic contexts that are difficult to interpret, Poz-60201 is a date from a topsoil, Poz-60298 is from a buried soil, and Poz-60197 is soil organic material. Only the date Poz-87547 dates a sample from a clear feature (ground floor under a platform), but in the overall context it is probably too young for the feature and possibly an intrusion. Accordingly, dates younger than ca. 3630 BCE are excluded from the analysis. Nevertheless, it remains striking that, with the exception of Poz- 87547, all younger dates cluster only in the SSW, especially also the three dates from 3630–3500 BCE. It is possible that some of this activity is related to the kurgan above SSW House Row 5 (Ohlrau 2020, 38, Fig. 10).

Results
The spatial distribution of the medians of the *termini ad quod* data according to the respective sections of the calibration curve provides a differentiated picture. The similarities and differences can be described by distinguishing the occupation and use of the different rows of houses and the infrastructure.

The following time-line emerges for a spatial and chronological occupation trend in Maidanetske (cf. Tab. 4; Fig. 38):

- From ca. 3970–3900 BCE, the few usable dates refer to an occupation of Ditch 1, of the inner part of Outer Area 3, of the ring corridor and the kiln. First houses are built in the Outer Area 3.
- Around 3900–3800 BCE, the occupation takes place from Ditch 2 to the Inner Area 1. Mega-structure 3 is also documented for the first time.
- Around 3800–3700 BCE, the above-mentioned settlement areas were supplemented by further inner rows of houses of the Inner Area 2 and those of the Outer Areas 1–2, so that now the largest extension of the mega-site was reached.
- From ca. 3700–3630 BCE, all activity is reduced to the area between and including Ditch 2 and the outer ring corridor.
- Later dates should be viewed with caution. The spatial proximity to the kurgan above SSW House Row 5 points to the possibility that they derive from activities that are related to the kurgan.

In consequence, after the first conceptual spatial design, we recognise intense settlement activities in the 39th century BCE with an expansion inwards and possibly outwards in the 38th century BCE.

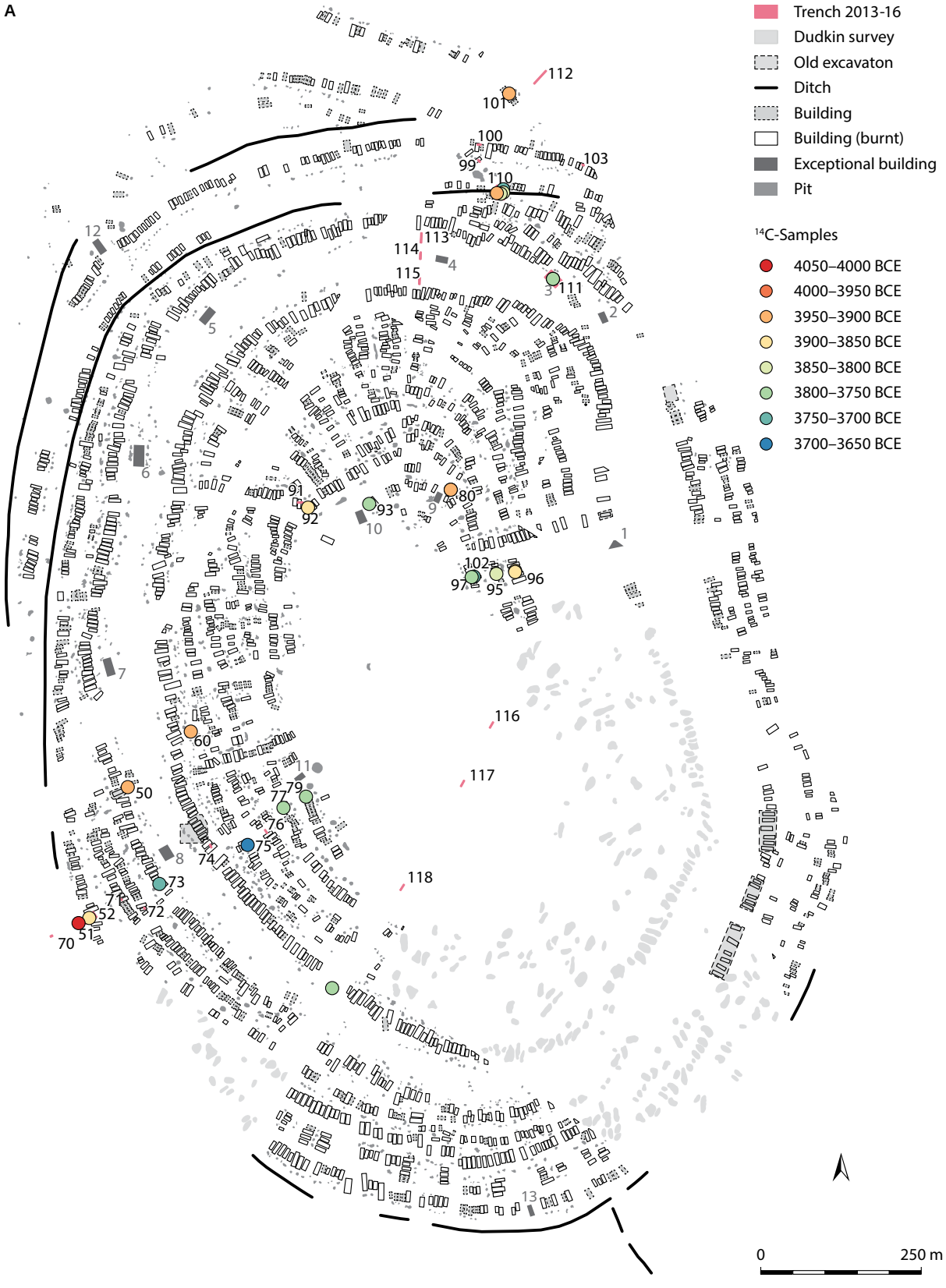


Figure 36. Maidanetske: distribution of early radiometric dates (cf. Suppl. 1–2). (A) according to 50-year time intervals; (B) according to the wiggle structure. Numbers indicate trenches.

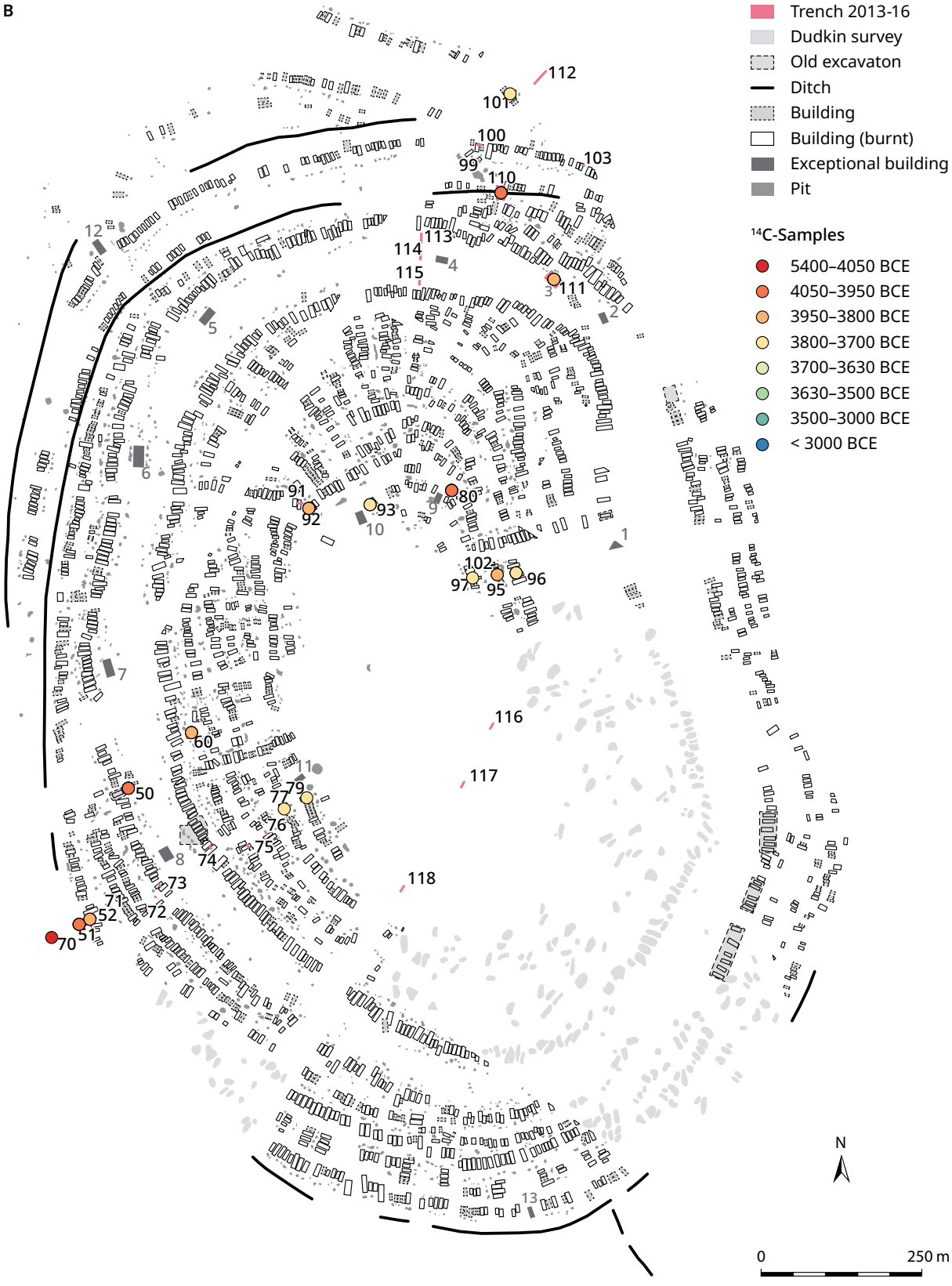


Figure 36, continued.

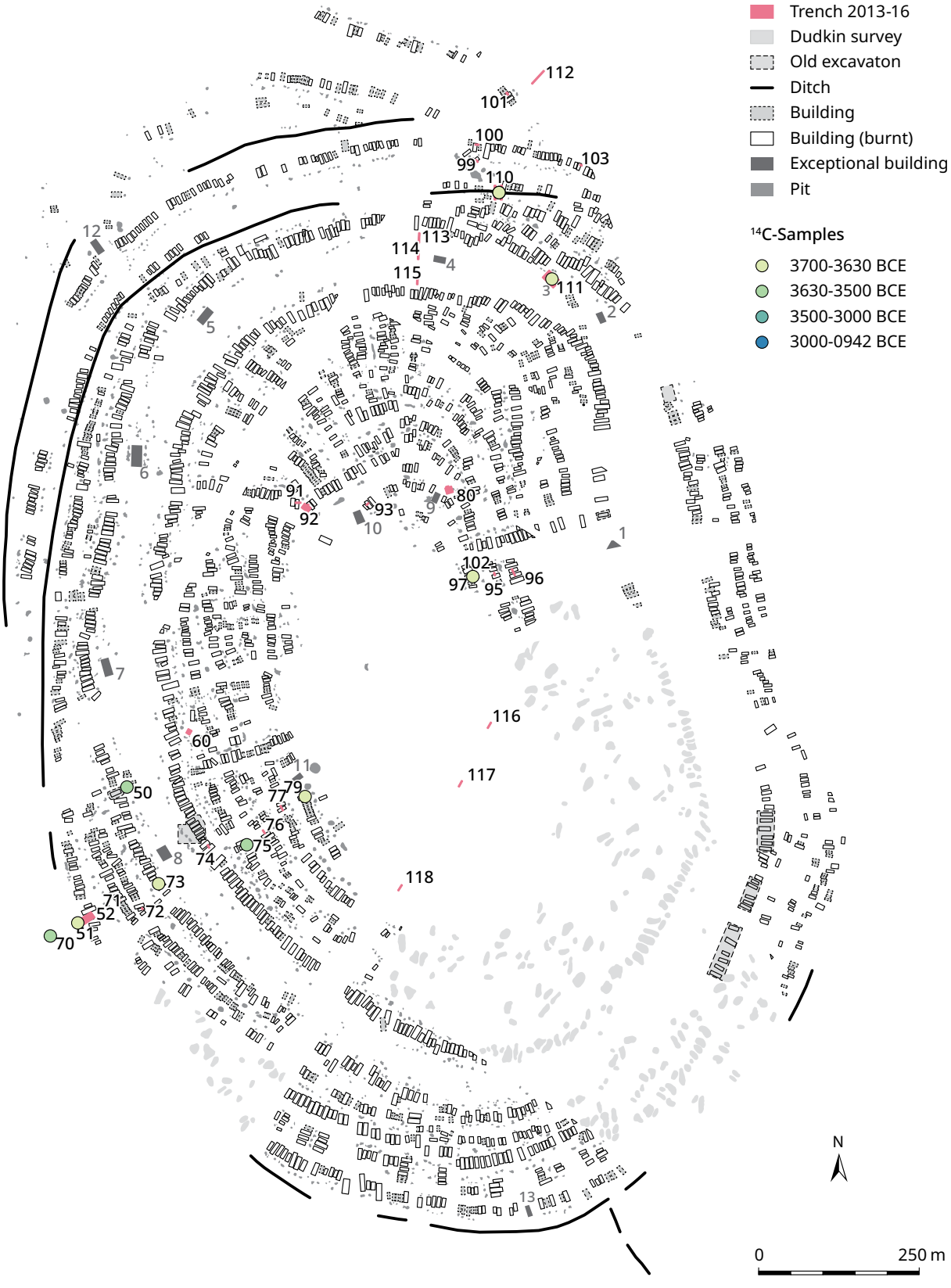


Figure 37. Maidanetske: distribution of late radiometric dates (cf. Suppl. 1–2).

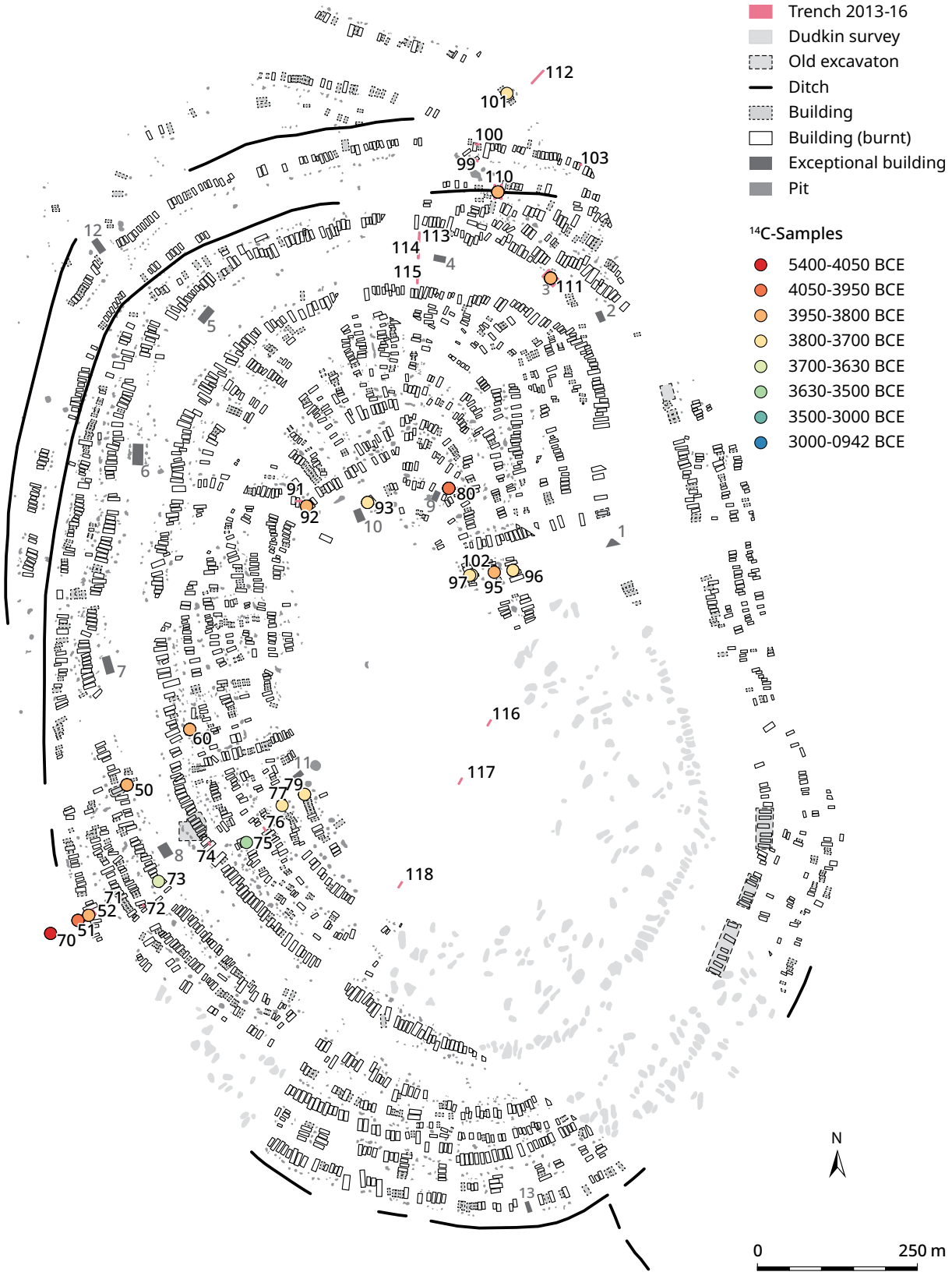


Figure 38. Maidanetske: spatial and chronological occupation trend (cf. Suppl. 1–2).

Kiln *(Kiln ph1/2 + Pit 2)* ***3940–3870 BCE****: Kiln Ph 3 + Pit 3 3870–3810 BCE, activities near kiln 3810–3755 BCE, also including 2 dates on the calibration interval 3990–3950 BCE*
Ditch system (western ditch 3905–3815 BCE; eastern ditch 3815–3720 BCE)*, earliest dates are within the dating interval after 3950–3800 BCE*
Pit trench 52 ***(Pit 26 4010–3640 (3960, 3740) BCE)*** *with one date on the dating interval 3990–3950 BCE*
*Pit trench 50 (****Pit 25 3910–3540 BCE****: 1b 3910–3800 BCE; 2a 3800–3680 BCE; 2b 3680–3540 BCE*
*Pit trench 60 (****Pit complex 27 3910–3780 BCE****: 60 ARCH-2 (3910–3845 BCE) and 60 ARCH-3 (3845–3780 BCE), remains from houses*
House 44 *Trench 51/52* ***3765–3680 BCE****: construction 3850–3765 (3795) BCE; use 3765–3680 (3725) BCE; cf. Ohlrau 2020, 206–207.*
House 47/48 *Trench 73a/b: waste area 3705–3380 BCE. Poz 60199 probably house 47: 3705–3640 (3680) BCE*
House 50 *Trench 75 only* terminus ante quem*: 3655–3650 BCE*
House 52 *Trench 77* ***3780–3660 (3735) BCE***
House 53 *Trench 79 3****760–3650 (3700) BCE***
House 54 *Trench 92 3****900–3850 BCE****: use 3900–3880 BCE; burning 3880–3850 BCE*
House 58 *Trench 93* ***3780–3660 (3735) BCE***
House 59 *Trench 94* ***3785–3660 (3740) BCE***
House 60 *Trench 95* ***3895–3675 BCE****: use 3785–3655 (3740) BCE (Poz 87535); occupation 3945–3710 (3845) BCE*
House 61 *Trench 96* ***3860–3685 BCE***
House 62 *Trench 96* ***3895–3660 (3770) BCE***
House 64 *Trench 101* ***3910–3710 (3790) BCE***
House 65 *Trench 102* ***3710–3635 (3680) BCE***
House 67 House trench 110 3830–3625 BCE: *House 67 and pit 3830–3715 (3790) BCE; occupation house 67 3715–3625 BCE*
Mega-structure 3745–3715 BCE: *Pits beneath mega-structure 3775–3745 BCE*

Table 5. Maidanetske: results of Bayesian calibrations of single features (cf. Suppl. 1–2).

Results of Bayesian calibration

In addition to the mapping of single dates, Bayesian dating of contexts was carried out where possible. In addition, there are individual contexts for which only single dates are available. For an overall mapping, the chronological boundaries of these dates were used. The mapping at the beginning and at the end of the features, mostly houses, gives an impression of the development in Maidanetske. The results of the Bayesian dating are summarised in Table 5, including the previous dating by René Ohlrau (2020, 203–230).

If we compile the dates according to the *older* boundaries of Bayesian dating, dates before 3900 BCE show up first in Pit 26 (Trench 52), in the kiln and finally in the ditch, followed by Pit 25 (Trench 50) and Pit 27 (Trench 60)[13]. Obviously, the basic concept or scheme of the settlement is laid out from the very beginning of activities at the site.

Whether House 64 in the northern area outside the settlement actually dates so early should be left open here. The spatial representation also indicates that there are activities from the entire area of the settlement during the entire period of occupation, but only after 3800 BCE also in the innermost area (Fig. 39). In this respect, a later occupation of the inner areas of the mega-site is indicated. If we map the most *recent* boundaries, we record the abandonment or desertion of certain areas of the settlement. According to this, we can assume desertion within the

13 There are tendencies that some activities start quite early. This is true for:
- the kiln (kiln Ph 1/2 + Pit 2 3940–3870 BCE, kiln Ph 3 + Pit 3 3870–3810 BCE, activities near kiln 3810–3755 BCE), also including 2 dates on the calibration interval 3990–3950 BCE,
- the ditch system (western ditch 3905–3815 BCE, eastern ditch 3815–3720 BCE), but the earliest dates are within the dating interval after 3950–3800 BCE
- and the Pit 26, Trench 52 (**Pit 26 4010–3640 BCE (3960, 3740)**) with one date on the dating interval 3990–3950 BCE.

Beside these early activities with the kiln, the ritual depositions in Pit 26 and the construction of the ditch, other houses and pits started around 3800 BCE, slightly differentiated in earlier and later ones.

settlement between ca. 3850 BCE and 3700 BCE mainly in the NNE, while delayed by several generations the SSW and the inner area (Fig. 40). This is in line with the spatial distribution of the single dates, which was described above (cf. Figs. 36–38).

The general Bayesian sequence of Maidanetske dates ends up with a model (A_{model}=70.9; $A_{overall}$=68.8) that implies a duration from ca. 3910–3600 BCE, which is in line with the results described thus far (Fig. 41). The Bayesian dating for single contexts and the critical mapping of individual dates falls into a similar range (ca. 3970–3630 BCE).

Results

The spatial distribution of the medians of the *termini ad quod* data according to the respective sections of the calibration curve, the Bayesian sequences of the contexts and the combined Bayesian dating of all Maidanetske dates provides a differentiated picture. Shortly before 3900 BCE, Ditch 1, the inner part of Outer Area 3, the ring corridor and the kiln are occupied and used. First houses are built in the Outer Area 3. From ca. 3900–3800 BCE, the occupation takes place from Ditch 2 to the Inner Area 1. Mega-structure 3 is also documented for the first time. Around 3800–3700 BCE, the above-mentioned settlement areas were supplemented by further inner rows of houses of the Inner Area 2 and those of the Outer Areas 1–2, so that now the largest extension of the mega-site was reached. At ca. 3700–3630 BCE, all activity is reduced to the area between and including Ditch 2 and the outer ring corridor. In conclusion, after the first conceptual spatial design, we recognise intense settlement activities in the 39th century BCE with an expansion inwards in the 38th century BCE.

The interpretation of the identified tendencies is simple at first. The few early ^{14}C dates (until 3900 BCE) are available from the entire ditch, the outer area between Ditch 1 and the ring corridor, from the outer ring corridor and the from inner area with the kiln. Moreover, until ca. 3800 BCE, the area between Ditch 1 and the Inner Area 1 is settled. Until 3700 BCE, the occupation of both the Outer Areas 1 and 2 and the Inner Area 2 also takes place. This is the most extensive occupation, which is reduced again in density until 3630 BCE.

If we convert the absolute number of dates in the time segments into relative numerical values (per ten years), a high proportion of building activities is particularly clear for the 39th century, but especially for the 38th century BCE. Subsequently, a decrease and end of the activities follow in the 37th century BCE (Fig. 42).

With these relative dates, we are additionally able to calculate the absolute number of houses in Maidanetske (2932; cf. Ohlrau 2020, 64, Tab. 7) with a simple model. First, we assume an average lifespan of 50 years for the houses (cf. Diachenko 2016; Millard 2020, 256; Ohlrau 2020, 233–236). Secondly, we calculate the number of contemporary houses according to the formula already described for Stolniceni (see previous section in this chapter on Stolniceni). According to the results, ca. 65 simultaneously existing houses were calculated for 4000 BCE, ca. 130 for 3925 BCE, ca. 1042 for 3850 BCE and 28 for 3675 BCE (Fig. 43).

The graph also presents the variation if assuming an average lifespan of 25 and 75 years for the houses, so that a margin of error can be seen. If we continue to assume that there were five residents per house, then ca. 160–490 persons lived in Maidanetske around 4000 BCE, ca. 325–975 persons around 3925 BCE, ca. 2600–7820 persons around 3850 BCE, ca. 3580–10750 persons around 3750 BCE and still 650–1950 persons around 3650 BCE. Around 3750 BCE, the highest number of inhabitants with 7200 (5 residents per house as calculated here) to 14,400 (10 residents per house) persons was reached. As the general Bayesian model for Maidanetske indicates a duration of the site, which is about 8.8% shorter than calculated by the multiple model (3910–3600 BCE (310 years) in contrast to 3970–3630 BCE (340 years)), the number of inhabitants might be even 8.8% higher: at the highest peak between 3900 and 11700 inhabitants (ca. 3750 BCE).

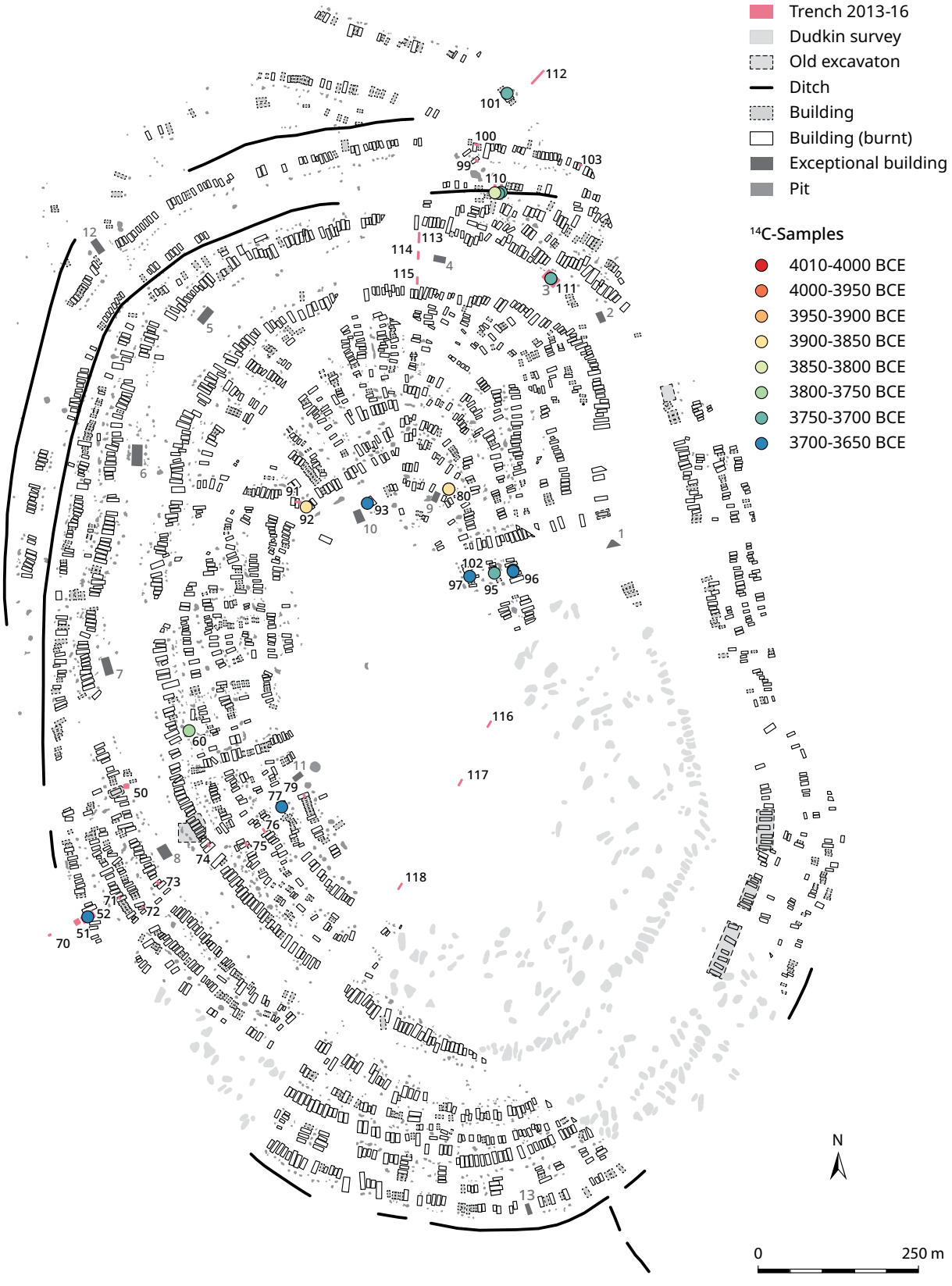


Figure 39. Maidanetske: distribution of early features (medians) according to the distribution of Bayesian calculations (cf. Suppl. 1–2).

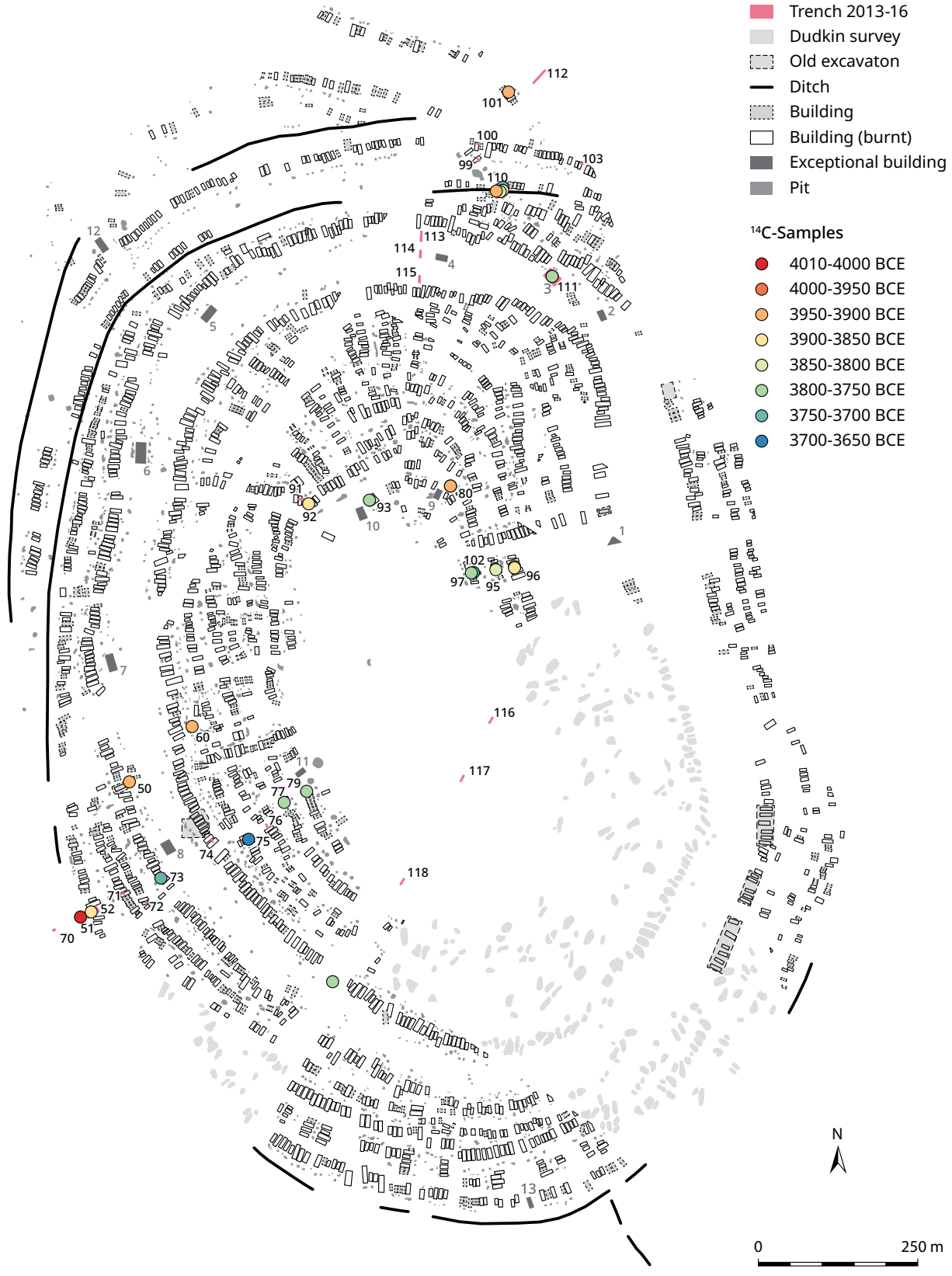


Figure 40. Maidanetske: distribution of late features (medians) according to the distribution of Bayesian calculations (cf. Suppl. 1–2).

Figure 41. The Bayesian calibrations of Maidanetske, all features (cf. Suppl. 1–2).
Due to the length of this figure, for ease of viewing it is only available online via the LandMan portal.

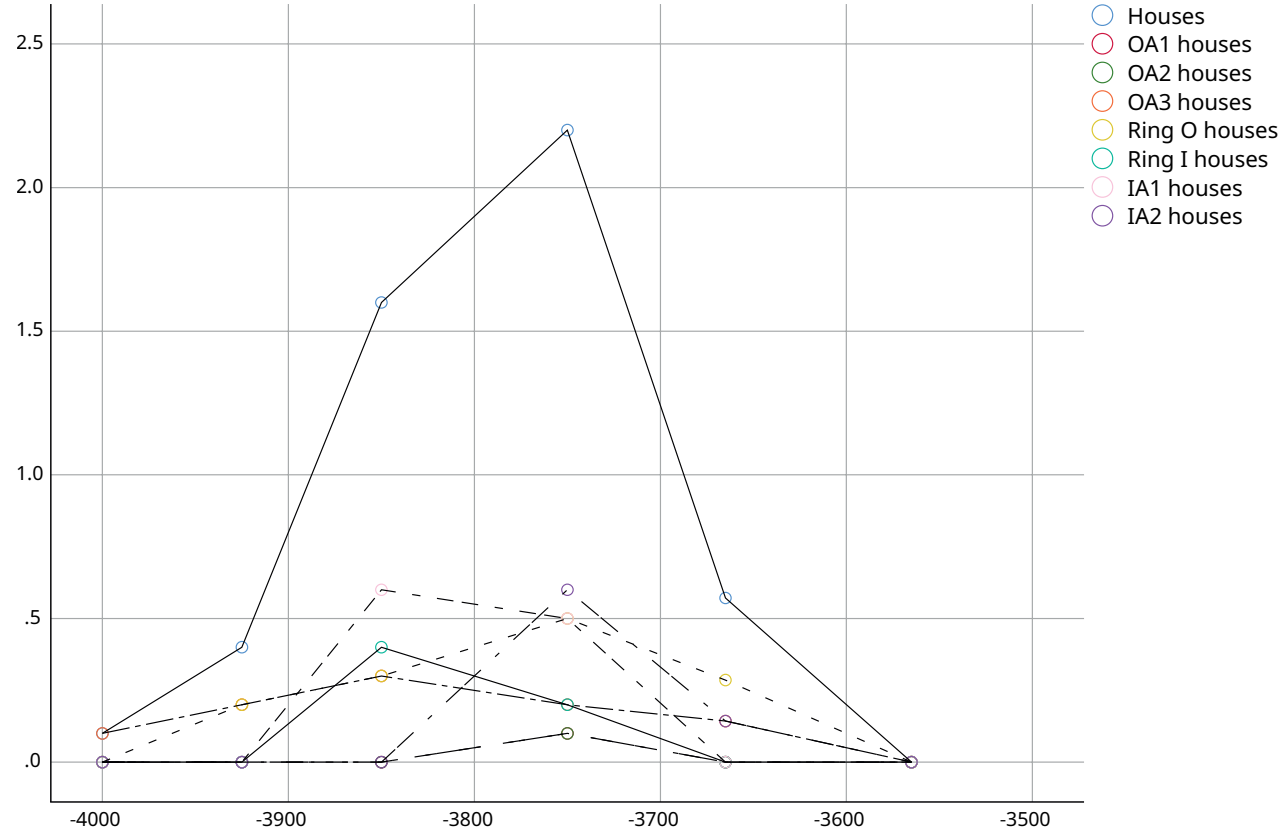


Figure 42. Maidanetske: the relative number of houses (conversion of the dated houses on a linear time scale). Key: A Area; I Inner; O Outer.

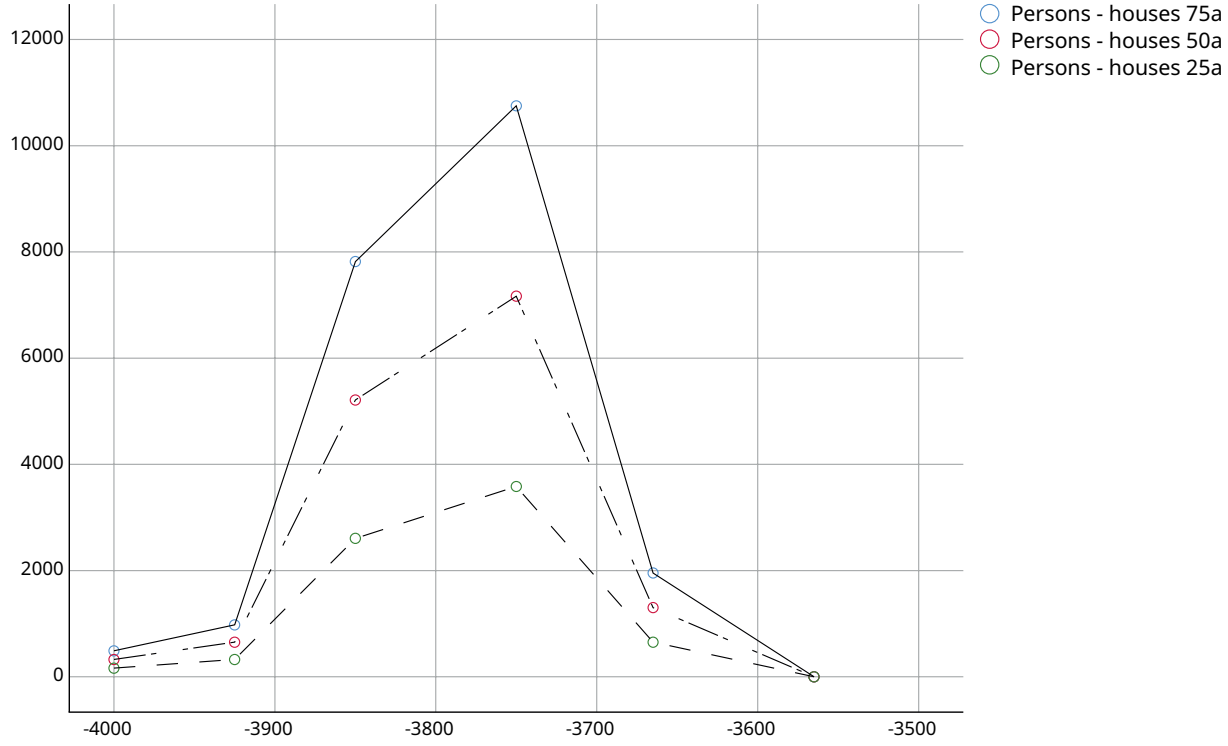


Figure 43. Maidanetske: the absolute number of houses (n) for the assumed use of the houses for 25, 50 and 75 years (a).

Talianki (C1)

The 320-ha site with 2200 houses and concentric planning, but without mega-structures, has provided 43 suitable samples from at least from 17 houses and one kiln (Ohlrau *et al.* 2016, 211, Tab. 5; Shatilo 2021, 101–103). Nearly all data fall into the dating intervals 3820–3780, 3780–3720, 3720–3700 and 3700–3660 BCE. Even if there is a small possibility of an older dating to 3940 BCE, this seems to be excluded by the estimated probabilities. The highest probability for the existence of the site spans from ca. **3825–3650 BCE**. A joint calibration has a model probability of A_{model}=72.7 / $A_{overall}$=61.8 – it is still within the range of values that are acceptable (Dury 2021).[14] The resulting duration probabilities of the houses and the kiln[15] are displayed in Figures 44 and 45.

Figure 44. The Bayesian calibrations of Talianki (cf. Suppl. 1–2 and Suppl. 2: Fig. 19). ***Due to the length of this figure, for ease of viewing it is only available online (https://doi. org/10.57892/100-55).***

From the structure of the calibration curve, at least a differentiation of three house phases is possible:

Phase A: 3810–3790 BCE: House 47 (3810–3790); **Phase B: 3780–3720 BCE**: House 50 (3800–3710), House 49 (3775–3700), House 46 (3790–3730), House 45 (3800–3710), House 43 (3760–3710), House 42 (3780–3720), House 40 (3750–3690), House 29 (3765–3690), House 19 (3770–3715), House 35 (3765–3675); **Phase C: 3720–3670 BCE**: House 48 (3760–3670), House 41 (3720–3680), House 28 (3710–3670), House 27 (3710–3640), House 37 (3765–3680), House 30 (3765–3675). The kiln is dated to **3805–3750 BCE.**

Even if the assignment to direct contexts in Talianki seems difficult, since the sample material for ^{14}C dating was taken from older excavations, we recognise a certain pattern at least in the NNW of the settlement (Fig. 46). Thus, with individual dates, three houses of House Row 1, which is in fact the outermost part of the ring corridor, date from 3900–3800 BCE and, with another radial house and a date from a pottery kiln, represent the oldest features. One house from House Row 2 and two from House Row 3 date to the following century. A house from House Row 1, dating at the same time, proves that this row of houses is now also being further settled. Further houses of House Rows 2, 3 and 5 belong to the period 3700–3630 BCE. Between 3630 and 3500 BCE, House Row 1 in the north is finally completed by another house. In the period thereafter, two more houses of House Rows 2 and 4 are found before the settlement is abandoned.

Thus, the data might indicate a tendency to start domestic activities from the outside to the inside, on the one hand, and an occupation of the house rows during all phases on the other. Thus, in the south there is also another house from 3700–3630 BCE and two more from 3630–3500 BCE belonging to House Row 1.

With these dates and the same approach, which was applied for Stolniceni, Nebelivka and Maidanetske, we are additionally able to calculate the absolute number of contemporaneous houses in Talianki (2200; cf. Ohlrau *et al.* 2016, 211, Tab. 5) with a simple model. First, we again assume an average lifespan of 50 years for the houses (cf. Diachenko 2016; Millard 2020, 256; Ohlrau 2020, 233–236). According to the results, ca. 465 simultaneously existing houses were calculated for 3825 BCE, ca. 580 for 3750 BCE, 810 for 3665 BCE, 230 for 3560 BCE, and 115 for 3440 BCE (Figs. 47, 48).

The graph also presents the variation if assuming an average lifespan of 25 and 75 years for the houses, so that a margin of error can be seen. If we continue

---

14 Excluded were Poz-109314 (5070,40) for House 19; Ki-15994 (4550,70) for House 40; OxA-19840 (5048,33) for House 41; Poz-109311 (4560,40) for House 42; Poz-82479 (4630,40) for House 49.

15 House 9 (3635–3530).- House 19 (3770–3715).- House 27 (3710–3640) 3695*.- House 28 3710–3640 3697.- House 29 3765–3690 3720.- House 30 (3765–3675) 3710.- House 35 (3765–3675).- 3710.- House 37 (3765–3680) 3715.- House 40 (3750–3690) 49 3.- House 41 (3720–3680) 37 3.- House 42 (3780–3720) 45 4.- House 43 (3760–3710) 44 3.- House 45 (3800–3710) 3760.- House 46 (3790–3730); 43 2.- House 47 (3810–3790) 19 3.- House 48 (3760–3670),3701.- House 50 (3800–3710) 3760.- Kiln F 3805–3750).

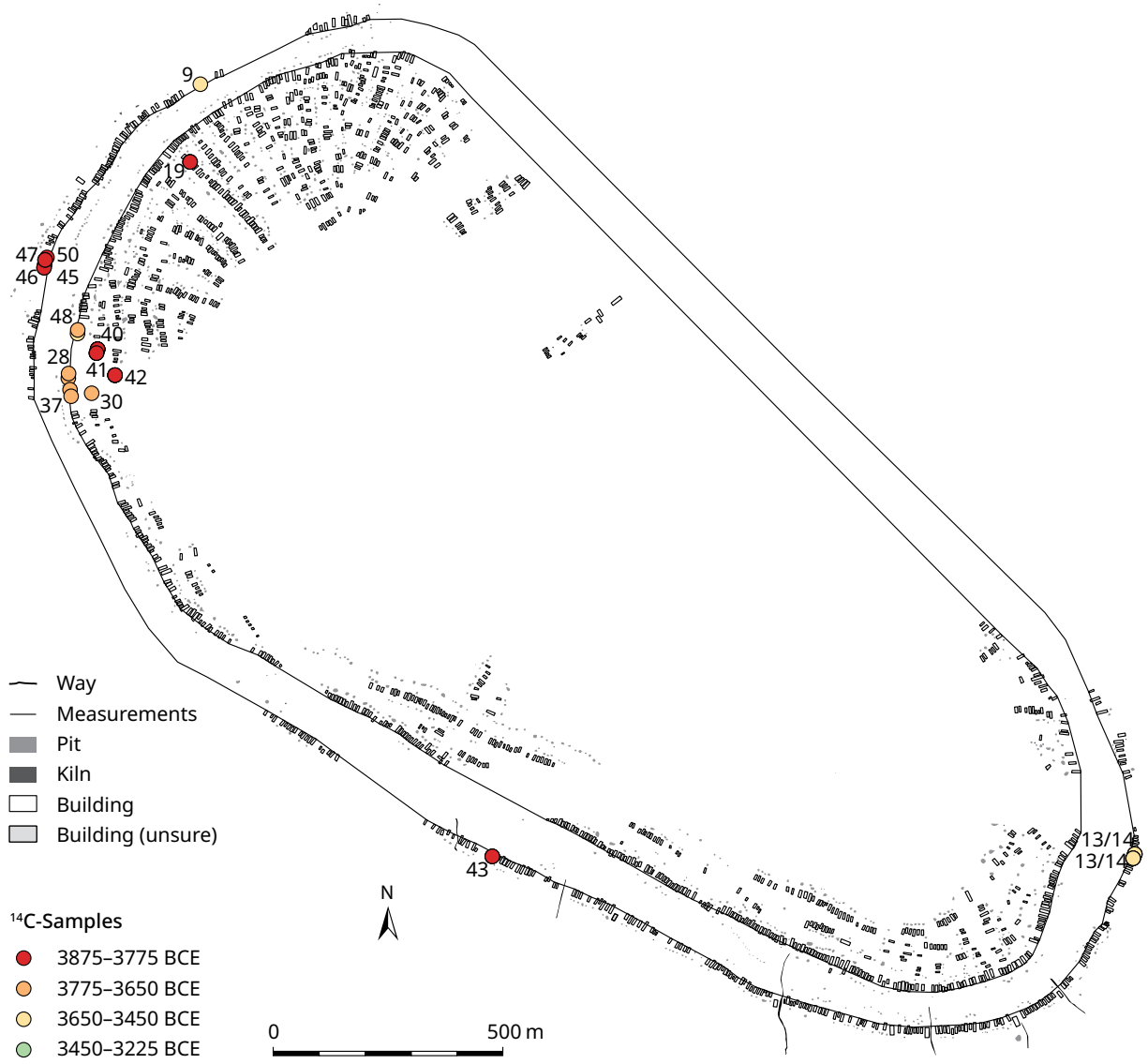


Figure 45. Talianki: distribution of late radiometric dates (cf. Suppl. 1–2). Numbers indicate trenches.

to assume that there were five residents per house, then ca. 1160–3470 persons lived in Talianki around 3875 BCE, ca. 1450–4340 persons around 3750 BCE, ca. 2030–6080 persons around 3675 BCE, ca. 580–1740 around 3560 BCE, and still 290–870 persons around 3500 BCE. In contrast to the longer occupation, which is indicated by the single dates (ca. 3950–3500 BCE: 450 years[16]), the general Bayesian model for the whole site ends up with a much shorter time span (3825–3650 BCE: 175 years). As the time span is 275 years shorter, the calculated population might be increased by 61%. Therefore, at the peak of the occupation around 3675 BCE, we would expect 3270–9780 inhabitants.

Kosenivka (C1–C2)

At the 100-ha site, 26 ^{14}C dates have been produced that belong – with one exception of an unknown origin – to House 3 and House 6 (Shatilo 2021, 137–140; Fuchs *et al.* 2024). The context and quality of the dates are special, as both human individuals and an animal specimen from a house have been dated. Thus, a deeper

16 Excluding the last phase, 3500–3380 BCE, which is probably due to later intrusions.

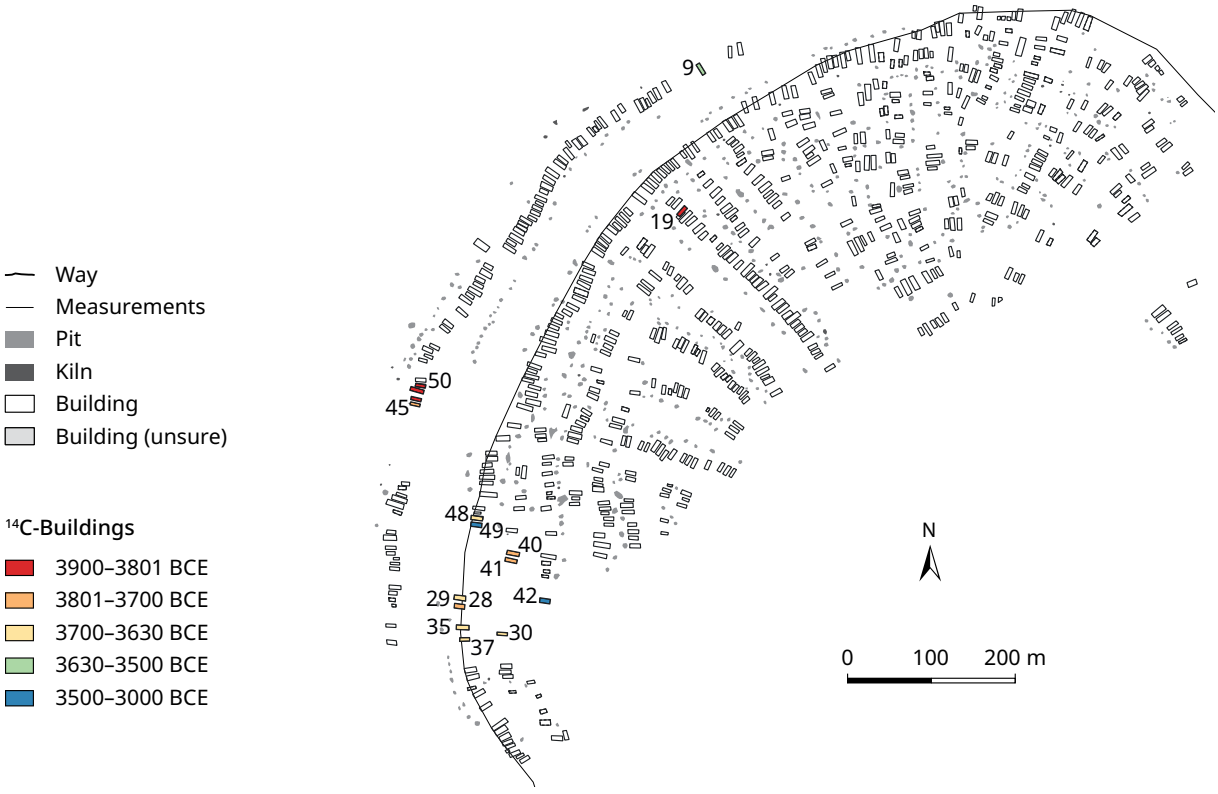


Figure 46. Talianki, NNW area: distribution of radiometric dates (cf. Suppl. 1–2).

analysis and a discussion of the data are relevant for the closer estimation of house duration as well (Fig. 49).

The dates were measured in three different laboratories, one of which differs slightly in average age, but not significantly. The sum calibration (2σ) of dates obtained for House 6 measured by the Poznan Laboratory spans a maximum range of 4240–3375 BCE, within which the date from the Leibniz Laboratory for the cereal grain from House 3 also falls (KIA-56328, 3710–3636 BCE). However, the sum calibration of the other five samples from House 3 results into a slightly younger age with a maximum span of 3645–3375 BCE (2σ; Fig. 49). Thus, an inter-laboratory discrepancy might be indicated.

House 0036

The 20 bone samples resemble eleven specimens, two of them burnt, from at least five human individuals and nine faunal specimens (Fuchs *et al.* 2024, Tab. 4). Based on the carbon and nitrogen isotopic values, we can exclude a major reservoir effect due to the consumption of aquatic food sources (Fuchs *et al.* 2024). After calibration, the human and faunal sample groups do not differ statistically, thus a comparable dating can be assumed. One calcined sample (individual 2, Poz-11086) pre-dates the other human samples. Due to the absence of stratigraphic evidence for this bone representing an older deposition, there is likely an offset explained by the 'old-wood effect'. In contrast, the oldest date of the occipital bone from individual 7 (Poz-131529, 3630–3374 BCE) coincides with its stratigraphically younger age as found in an upper layer. Thus, this could represent a later deposition. Apart from these two dates from individuals 2 and 7, the other samples resulted in a statistically consistent time range between ca. 3800 and 3600 BCE.

To improve the interpretative value of the results, we applied Bayesian modelling (Fig. 49) considering the one stratigraphic information and by separating human and faunal samples as two different. Sequences were created by separating (i) the youngest date with the stratigraphically younger age, (ii) the broader dated



Figure 47. Talianki: the relative number of houses (conversion of the dated houses on a linear time scale).



Figure 48. Talianki: the absolute number of houses (n) for the assumed use of the houses for 25, 50 and 75 years (a).

human samples and (iii) the faunal samples (OxCal functions boundary, phase and sequence, calculating 1σ and median values; Fig. 49). The model generated a high statistical significance (A_{model}=120.9 / $A_{overall}$=111.1)[17]. The main results are:

- The humans (individuals 3, 5, and 6) and animals represented by the analysed samples died approximately between 3690 and 3620 BCE (calculated median interval 79 years).
- The animals died between ca. 3660 and 3645 BCE (calculated median interval 11 years), the humans (individuals 3, 5, and 6, ++) between ca. 3670 and 3635 BCE (calculated median interval 37 years).
- The human skull bone was probably deposited on the upper layer of the already burnt house; thus individual 7 died between ca. 3620 and 3380 BCE (median 3500 BCE).

Figure 49. The Bayesian calibrations of Kosenivka (cf. Suppl. 1–2).
Due to the length of this figure, for ease of viewing it is only available online (https://doi.org/10.57892/100-55).

The shorter intervals of the animals can be explained by their shorter lifespan in comparison to humans. Cattle, for instance, were usually slaughtered at 10 years of age, while eight out of nine human samples from this model stem from adult individuals.

Overall, the data are statistically close enough that the calculated lifetimes of the animal and human individuals associated with House 6 are probably more consistent with the human results than with the overall calculation. It is very likely that individuals 4–6, plus potentially those represented by isolated bones (5/6++), died during the occupation period of the house. Only individual 7 died ca. 130 years later, and its skull bone was deposited probably after the house was already abandoned.

House 3

As mentioned above, the date of the cereal grain analysed at the Leibniz Laboratory fits with the dates obtained for House 6, while the faunal bones analysed at the Penn State Laboratory have a longer probability span towards a younger age. Altogether, the samples for House 3 date from ca. 3675–3535 BCE. Giving more significance to the cereal grain date, since a laboratory bias is strongly indicated, the house was in use from ca. 3702–3640 (median 3680) BCE, thus contemporary with House 6 (Fig. 49).

Settlement Kosenivka

On the basis of dates measured at the Leibniz Laboratory and the Poznan Laboratory, we conclude that Houses 3 and 6, including humans, animals and cereals, existed somewhat contemporaneously between 3700 BCE and 3620 BCE (medians). Further activities on the site took place some generations later (the deposition of the skull bone, the faunal bone from an unknown context), probably around 3500 BCE. Thus, our results place the settlement Kosenivka in late Trypillia C1 and some activities in C2, but mainly in the final phase of Middle Trypillia. Overall, these results support the hypothesis of Kruts and colleagues that the humans represented by the skeletal remains found in House 6 died at the same time, possibly in a fire (Kruts *et al.* 2005; Fuchs *et al.* 2024).

Sharin 3 (C2)

The destroyed small site yielded different samples from a rescue excavation, which date to the Bronze Age and C2. Four datable samples belong to Trypillia C2 contexts that are difficult to define (Shatilo 2021, 140). They date from **3740–3510 BCE** (Fig. 50).

17 One of the arm bones, Poz-109981, does not fit. But since the two dates from the same frontal bone failed when applying the OxCal function combine, we consider them an analytical bias.

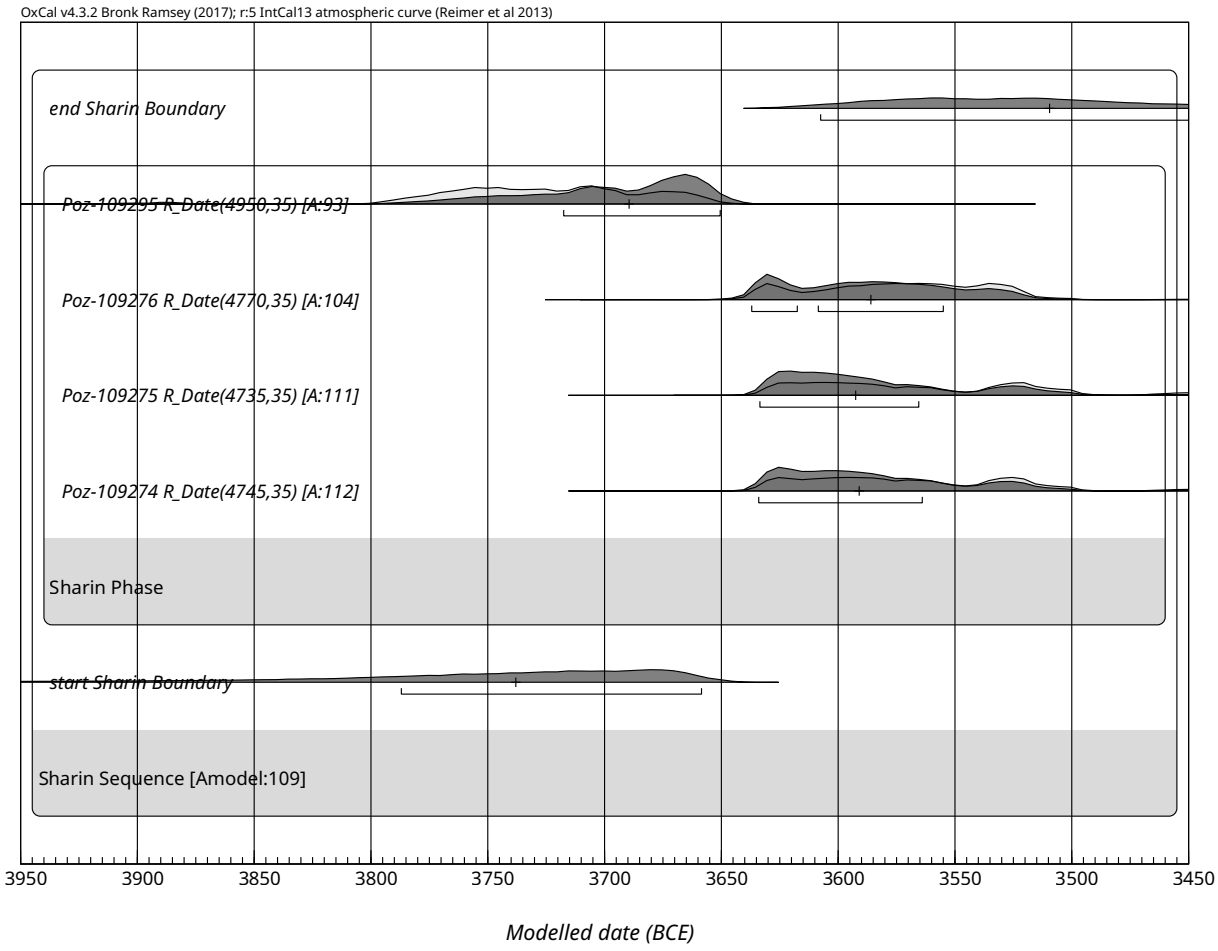


Figure 50. The Bayesian calibrations of Sharin 3 (cf. Suppl. 1–2).

Summary

In the eastern Trypillia area we would estimate Trypillia as follows: A3 4540–4380 BCE; B1/2 4130–3910 BCE; B2 4020–3800; C1 3970–3625 BCE and C2 3740–3510 BCE (Fig. 51).

Contemporaneity of houses and other structures

Obstacles

As the settlement behaviour uses available space to build houses at a distance to older houses, useful stratigraphy is normally missing for dating purposes. Furthermore, samples for dating are often lacking because of acid soil conditions or high burning temperatures. In consequence, most Bayesian models for single houses are based on only a few samples in a very simple stratigraphy. Thus, a dwelling is usually associated with a pit at a small distance from one of the house's broadsides. Accordingly, a house place is indicated by the stratigraphy of a pit, which also could inform us about the occupation of the house in the vicinity.

As an example, Maidanetske House 44 has a stratigraphy with 3 archaeological layers of different depositional processes (Müller *et al.* 2017, 36–37, Tab. 4, Fig. 15). Moreover, the nearby Pit 26 (Trench 52) displays different layers, for which again different depositional processes are known. As such, we can differentiate between *termini post quem*, *ad quem* and *ante quem*. In consequence, a rough dating of the house from 3800–3650 BCE is highly probable (Fig. 52). If we link information from both units, a plausible Bayesian model is calculated (A_{model}=99.3., $A_{overall}$=99). According to this model (Ohlrau 2020, Fig. 123), the construction pit was

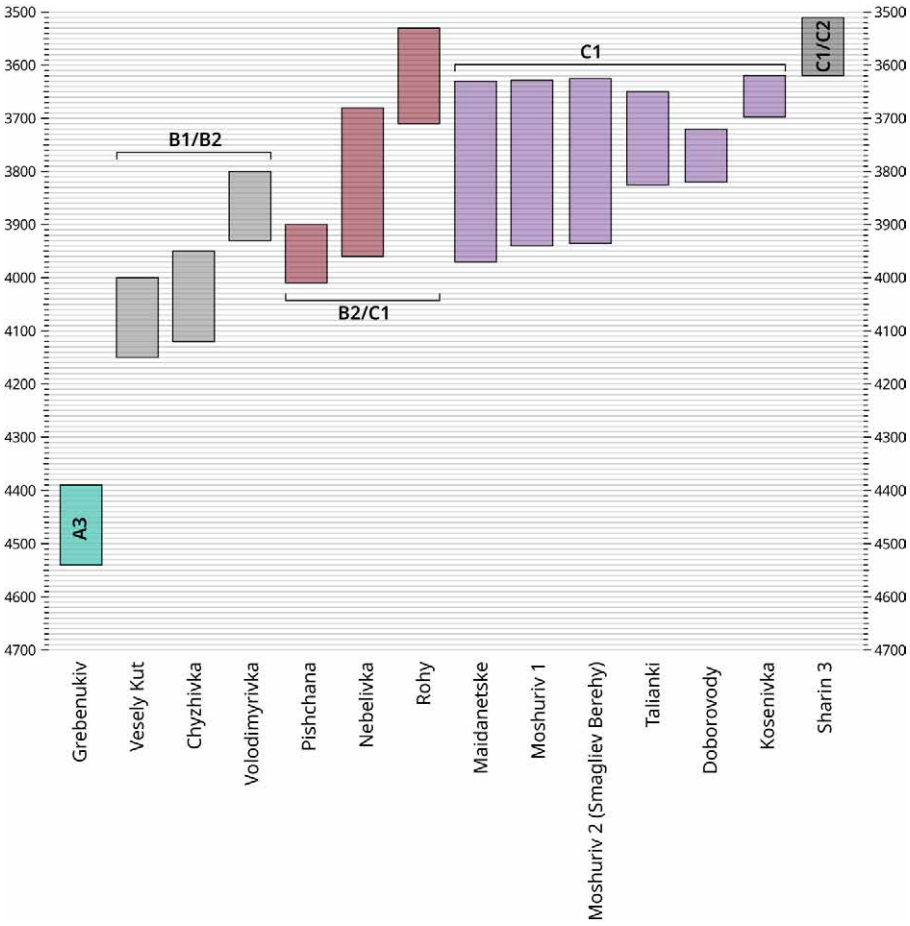


Figure 51. The comparison of Bayesian dates of individual sites from the Southern Bug-Dnieper interfluve.

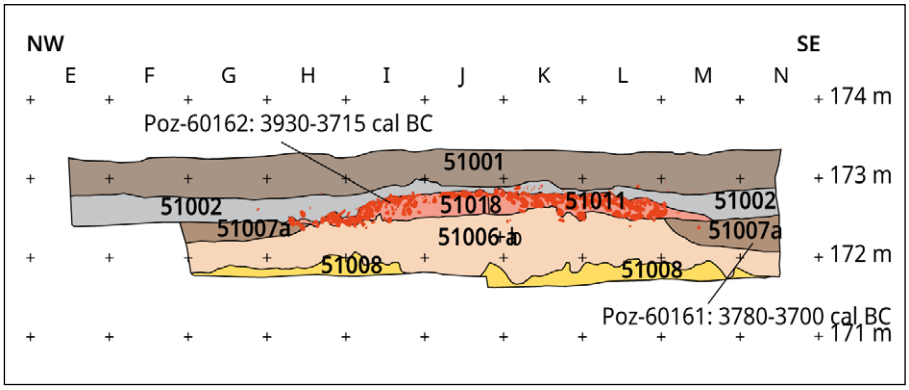
dug prior to 3775–3730 (68.2%) or 3795–3700 modelled BCE (95.4%) respectively, while the house was in use in the time between 3750 BCE and 3710 BCE (68.2%) or 3780 and 3665 modelled BCE (95.4%), respectively. The occupational layer shows general activity in the area between 3780 BCE and 3700 BCE (68.2%) or 3905 BCE and 3655 BCE (95.4%), respectively.

House durations

^{14}C dates are available for numerous houses/mega-structures. However, we only know of more than three ^{14}C dates for 31 houses/mega-structures, which are listed in Table 6. In Oxcal, the chronological construction or usage period of the individual units and the interval of duration were calculated for the different cases. In order to improve the display for the identification of trends, the median of the modelled 1-σ duration or the 1-σ limits and the median of the duration of the interval were recorded in each case.

Different observations can be made:

- The more ^{14}C dates, the shorter the modelled lifetime of the houses and mega-structures. From about 4 available ^{14}C dates onwards, however, the value levels off (Tab. 7).
- The median values of duration hardly differ between >3 ^{14}C dates and those units including 3 ^{14}C dates. The base set is 11 to 24, the median amounts to 30–40.5 years duration (Tab. 8).
- The duration of the houses in Maidanetske and Talianki indicates a prolongation of the median values from about 30 years to about 70 years. In Nebelivka, no trends can be observed (Fig. 53).



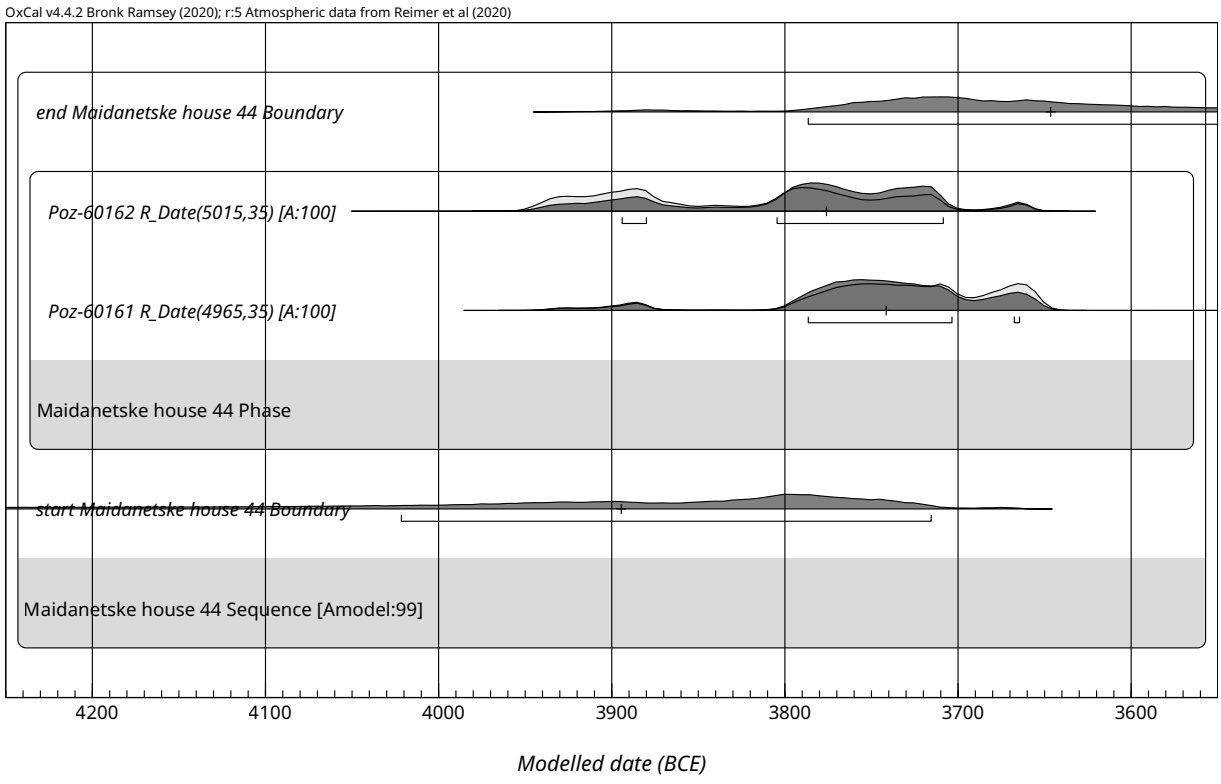


Figure 52. Bayesian dating of Maidanetske House 44: (A) Location of the samples (Müller et al. 2017, 36–37, Tab. 4, Fig. 15) and (B) Bayesian modelling.

- The general representation, including all cases, also indicates an increase in the lifespan of houses and a decrease in the lifespan of mega-structures over time (Fig. 54).
- Mega-structures seem to exist for a shorter time than houses. However, only 3 examples are available (Tab. 9). In summary, even if the number of ^{14}C dates is small, the few examples indicate a use span for houses of usually about 30–35 years with a tendency to use houses longer in later phases (Suppl. 4; Fig. 53). Although the 2-σ values are different, the clear tendency points to an average house duration of ca. 60 years.

'A house constructed of timber is likely to be [used for] a few decades' (Millard 2020, 256), a conclusion from the TOTL Project, which has investigated the duration of Neolithic houses. A variation is observed from ca. 15–80 years (cf. Draşovean and Schier 2010 on Uivar, Romania).

House/ Mega-structure	1 sigma probability BCE	Duration (a)	n ^{14}C, Mod/Ind	Remark
Bilyi Kamin house 7	3865-3895 3915-3875	17 32	3 92.1 89.2 3 105.9 104.5	Integrated model Lonely model
Kosinivka house	3675-3650 3660-3645	11 11	6 110.4 116.3 6 121.9 131.9	Integrated model Lonely model
Mai house 54	3950-3880 3900-3850	70 27	5 oa 81.8 84.7	Ohlrau 201
Mai house 44	3765-3680	74	(4) 2 oa 81.8 84.7	
Mai house 67	3700-3635 3715-3625	65 93	3 oa 81.8 84.7	Ohlrau 214
Mai pit 60 Arch 3	3775-3710 3845-3780	65 48	5 oa 81.8 84.7	Interpretation as house debris
Mai house 53	3780-3690	80	3 oa 81.8 84.7	
Mai pit 60 Arch 2	3910-3760 3910-3845	150 48	5 oa 81.8 84.7	Interpretation as house debris
Neb house A9	3935-3800	125	3, 112.9 112.3	
Neb house B17	3960-3775	195	2, 103.3 103.5	Megastructure?
Neb tp 29/4 (3,4)	3920-3860	30	6, 87 92.6	2 intervalls of 15 years used in model, could also be 60 years
Neb tp 29/4 (3,4) house duration	3900-3855	30	6, 93.8 97.8	1 Interval calculated
Neb tp 24/3 (3,4)	4040-3850	180	3, 114.6 112.8	2 Intervals
Neb 24/2 (3)	3935-3810	103	3, 98,6 100,1	
Neb tp 25/3 (4)	3790-3635	165	3, 93.4 95.2	
Neb tp 26/4 (3)	3895-3845	30	4, 104.4 106.6	
Pishchana house 3	3980-3953 4085-3650	24 466	4 121.1 122.1 3, 87.7 87.9	Integrated model Lonely model
Pishchana house 2	3955-3930 3950-3810	23 122	3 121.1 122.1 3 99.3 99.9	Integrated model Lonely model
Stolniceni house 7	3880-3830 3810-3775	20 31	4, 118.9 117.6 6, 87.9 94.4	All, integrated Red. by 1 date
Talianki house 46	3790-3730	43	2, 72.7 61.8	Integrated model
Talianki house 47	3810-3790	19	3, 72.7 61.8	Integrated model
Talianki house 40	3750-3690	49	3, 72.7 61.8	Integrated model
Talianki house 41	3720-3680	37	3, 72.7 61.8	Integrated model
Talianki house 42	3780-3720	45	4, 72.7 61.8	Integrated model
Talianki house 43	3760-3710	44	3, 72.7 61.8	Integrated model
Talianki house 19	3770-3715	45	2, 72.7 61.8	Integrated model
Dobrovody MS	3790-3720 3900-3710	20 160	3 112.3 113.2 3 112.3 113.2	Integrated model Lonely model
Maid MS	3745-3715	20	9, oa 81.8 84.7	
Neb house B17	3960-3775	195	2, 103.3 103.5	Megastructure?
Neb MS 26/3	3785-3680	100	2, 102.7 103.1	Only 2 dates
Neb bMS	3925-3820	90	3, 107.8 106.2	2 Intervals for 2 phases calculated

Table 6. The duration of houses (cf. Suppl. 1–2: 4).

House lifespan (a)				
Duration		n	Standard Deviation	Median
n ^{14}C	Mean			
3	75.71	14	53.184	64.50
4	43.25	4	22.322	37.50
5	33.50	4	17.972	37.50
6	30.50	2	.707	30.50
9	20.00	1	.	20.00
Sum	57.92	25	45.578	44.00

Table 7. ^{14}C dates and house duration (cf. Suppl. 4): The more ^{14}C dates, the shorter the calculated lifetime of the houses and mega-structures. From about 4 available ^{14}C dates onwards, however, the value levels off.

House lifespan average (a)		
	Duration	
n	Valid	25
Mean		57.92
Median		44.00
Percentile	25	25.50
	50	44.00
	75	85.00

Table 8. ^{14}C dates and house duration (cf. Suppl. 4): The mean, median and percentile values of duration for units with >2 ^{14}C dates.

Nevertheless, the analyses of seven houses in Maidanetske indicate high probabilities for the contemporaneity of houses within a timeframe of about less than one century. In cases where stratigraphic information is available, a house duration of less than 50 years is most probable (Houses 79, 54, 61). Pits, which are in many cases associated with the domestic houses and house places, indicate short lived periods. Elongated pits from enclosures yield ^{14}C dates which show short sequences.

Combining different models on the house sequences within concentric rows or within whole settlements, a contemporaneity of 40–60% of the houses is the one estimation with the highest probability.

Development of local mega-sites

With the 96 ^{14}C dates from Maidanetske, tendencies for different features of the settlement are indicated that aid in the reconstruction of the settlement development. The oldest radiocarbon dates (around 3990–3935 BCE, Phase 1) belong to one of the outer enclosures, and from the 3-channel-pottery-kiln, which is located nearer to the centre of the site. Further dating of dwellings indicate that the concentric space between the mentioned enclosure and the kiln was settled first from the innermost concentric circle (3935–3800 BCE, Phase 2), but a house was also constructed in the outermost circles, which does not follow the general later pattern. Remaining pits from this older settlement to the north of Maidanetske also date to Phase 2.

Later, the innermost part of the site is settled from ca. 3800–3700 BCE (Phase 3) as well as the inner and outer main ring up until the outer ring of houses right behind the inner enclosure. René Ohlrau (2020) discovered the peak occupation from ca. 3765–3710 BCE with the densest number of houses within the inner enclosure. The excavated mega-structure also belongs to this Phase 3. The excavated kiln and its pottery production ceased already around 3800 BCE and was not continued in Phase 3.

In a further development, the inner enclosures were levelled and a younger house was built on top (ca. 3700–3640 BCE, phase 4). Further younger dates belong to the outer parts of the site.

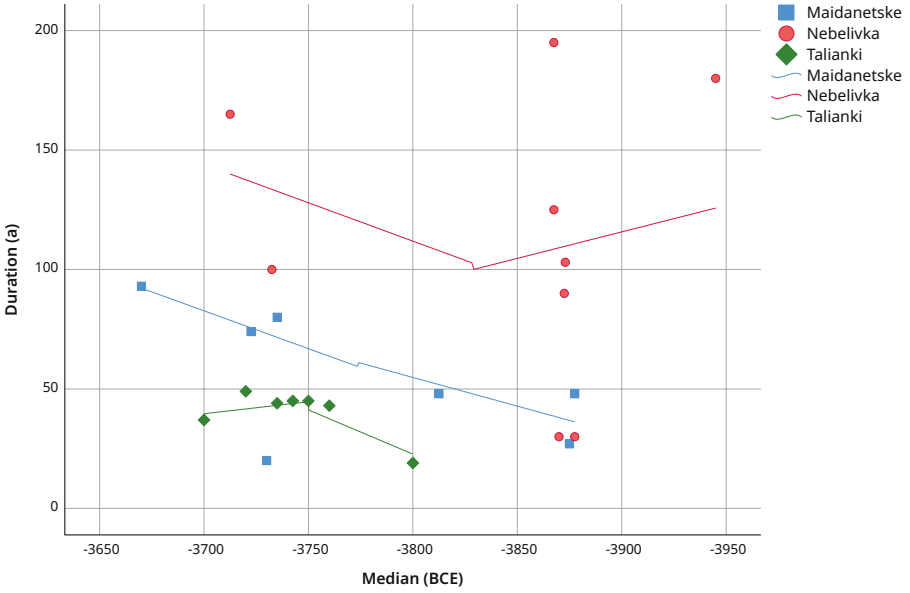


Figure 53. The calculated duration of the houses in Maidanetske, Talianki and Nebelivka. For Maidanetske and Talianki, a prolongation of the median values from about 30 years to about 70 years is indicated. In Nebelivka, no trends can be observed (cf. Suppl. 4).

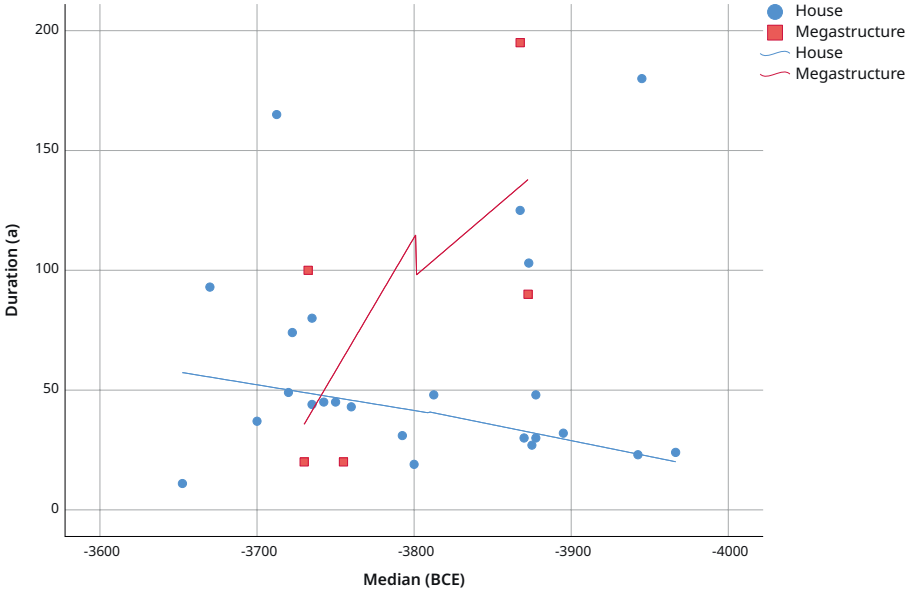


Figure 54. The calculated duration of the houses and mega-structures. The general representation including all cases indicates an increase in the lifespan of houses and a decrease in the lifespan of mega-structures over time (cf. Suppl. 4).

Duration (a)				
Duration		n	Standard Deviation	Median
Category	Mean			
Houses	59.91	22	46.73	40.50
Mega-structures	43.33	3	40.41	20.00
Sum	57.92	25	45.57	44.00

Table 9. The general duration of houses and mega-structures (cf. Suppl. 4).

In summary, the temporal-spatial distribution of the radiometric dates describes the establishment of a demarcation and infrastructure in the early phase of the settlement, followed by main settlement activities in the intermediate phase and a final phase with an occupation of lower intensity.

A comparable situation exists at other sites, where the number of radiometric dates is high enough for differentiations of the site biography. In Stolniceni, the outer enclosure and the kiln also yielded the oldest dates before the main occupation started. In Maidanetske, the kiln functioned earlier than the houses.

Beside the qualitative differences of the occupation phases, the modelled house durations of 19 dated houses in Maidanetske are taken for the estimation of the occupational time of these houses. In result, the duration of occupation lies probably in a time window of 25–75 years. Taking this into consideration and summing up the calibrated values for all sites, the number of contemporaneously occupied houses per phase is displayed in Figure 42.

Due to the previously known radiometric dates, the three large settlements – Nebelivka, Maidanetske and Talianki – coexisted for a long period of time, even if the core occupation of Nebelivka began earlier than Maidanetske and Talianki, and the latter two were occupied longer (cf. Shatilo 2021, 152, Fig. 55; Nebbia *et al.* 2018). By means of a structural comparison of the spatial-chronological processes at Talianki and Maidanetske, which were analysed and described elsewhere (Ohlrau 2020; Shatilo 2021), the following can be stated (Fig. 55):

- In all three settlements, the oldest dates are located at the outer boundary of the mega-sites. In Maidanetske, these dates are from the enclosure, in Talianki from the outermost concentric house row and in Nebelivka also from the outer house row. Unfortunately, it was not possible to gain radiometric dates from the outer enclosure at Nebelivka. Nevertheless, as in Maidanetske, an early construction of the outer boundaries of the settlement area can also be assumed here.
- In all three settlements, the radiometric dates indicate that both the concentric house circles and the inner quarters existed as a fundamental concept and could be settled. Both the investigations of Liudmyla Shatilo in Talianki and the spatial distribution of our ^{14}C dates in Nebelivka reveal that originally empty areas were progressively settled in the concentric rows of houses. This was also likely the case in Maidanetske.
- While corresponding settlement processes in Talianki and Maidanetske all included concentric circles and quarters, this is no longer the case after 3800 BCE in the inner area of Nebelivka, but only in the outer areas of the settlement.

From our point of view, the latter observation captures the crucial difference between Talianki and Maidanetske, on the one hand, and Nebelivka on the other: In all three cases, we observe a basic settlement planning concept right from the start of the settlements. While the settlement processes in Talianki and Maidanetske are intensified over time, these are already discontinued in Nebelivka after a few generations. The activities are limited to the periphery of the settlement, while the inner area no longer plays a role.

As a consequence, we can deduce that in contrast to Maidanetske and Talianki, Nebelivka was discontinued earlier. The original concept of a large settlement at Nebelivka, which pre-programmed an urban development with the creation of the 235-ha settlement area, the ring corridor and the quarters, was abandoned for reasons still unknown to us.

The population increase in Maidanetske around 3800 BCE, which occurred at the same time as the beginning of disintegration at Nebelivka, could indicate greater mobility between the mega-sites. Therefore, it is possible that other mega-sites could have profited in their development from the demise of Nebelivka.

The cause of Nebelivka's decline can, for example, be sought in the economic sphere. At first, no major differences can be detected between the three mega-sites considered here. The isotope values of domestic animals indicate that at least some of the animals in Nebelivka, in contrast to Maidanetske, still found more wooded areas in the surroundings (Makarewicz *et al.* 2022). Analyses of molluscs directly

from archaeological features in Nebelivka, however, also verify a cleared landscape (Miller 2020). A pollen profile from the nearby canyon at Nebelivka (Albert *et al.* 2020) covers, according to the five accepted ^{14}C dates, the period between 4400 BCE and 3500 BCE. The pollen diagram indicates light forest cover before settlement with a mixed oak forest interspersed with pines. However, the settlement time of Nebelivka falls in a hiatus in the pollen profile between 4100 BCE and 3600 BCE, so that a further clearing and the appearance of settlement indicators, including micro-charcoal, are not documented. A sparse forest is also proven for the time after the settlement. In principle, other palaeoecological analyses point to a sustainable economy, which led, among other things, to the development of anthropogenic black soils (Dreibrodt *et al.* 2020). For Nebelivka, this cannot be verified, since the mega-site was abandoned relatively early.

If we compare the development of the three mega-sites where we are able to reconstruct the internal development, similarities and differences are obvious (Fig. 55):

1. The peak of the occupation falls in different centuries: the 39th century BCE in Nebelivka, the 38th century BCE in Maidanetske and the 37th century BCE in Talianki.
2. While Nebelivka reaches a population size of only less than 2000 inhabitants, Maidanetske reaches about 7000 inhabitants and Talianki 4000 inhabitants (average).
3. While in Nebelivka and Maidanetske the population increase and decrease reflect a boom and bust phase, in Talianki the overall-development makes a smoother impression.

Nebelivka was lost. Therefore, it never reached the same population density as Talianki or Maidanetske, on the one hand, and did not have such a long period of settlement on the other. In the 38th century BCE, we observe ca. 1500 contemporaneously existing houses at Maidanetske, in Nebelivka only ca. 300. This shows differences in settlement – how it was originally conceived, enabling a corresponding densification of the residential areas (in Maidanetske), and a settlement (Nebelivka), which originally had a very similar concept, but whose housing densification never took place due to reasons yet unknown.

The temporal synchronisation of Trypillia phases

Figure 56 displays a comparison of Trypillia phases between the three regions, as visible from the radiometric dating used here. While in the west, Precucuteni 3/1 and Cucuteni A1 are dated between ca. 4700 BCE and 4300 BCE, in the east, Trypillia A3 dates from ca. 4540–4380 BCE, thus contemporary with CC A1. Trypillia B1 sites are dated in the west around 4300–4150 BCE. They are missing in the central region and are not dated in the east, where they might fall within the dating gap between A3 and B1/2.

Trypillia B1/2 existed probably contemporaneously around 4300–4000 BCE in the west and the middle region, starting later in the east, but lasting longer there (4130–3900 BCE). B2 is also known around 4050 BCE in the west, at 3970 BCE in the middle and 4020 BCE in the east. A more or less concurrent beginning of B2 seems to be possible, taking the dating uncertainties into account, while it seems to last until 3800 BCE in the east, but seems to cease much earlier in the middle (3900 BCE) and the west (3950 BCE). A contemporaneity is also implied by the start of C1 in all regions around 3970/3950 BCE. The end of C1 might be 75/100 years earlier in the west than in the middle region (3610 BCE) and the eastern regions (3625 BCE). Trypillia C2 is determined by a date from Kosenivka around 3620–3520 BCE for the east, contemporaneous with the middle region (3620–3520 BCE), but it may be later than in the west (3490–3040 BCE).

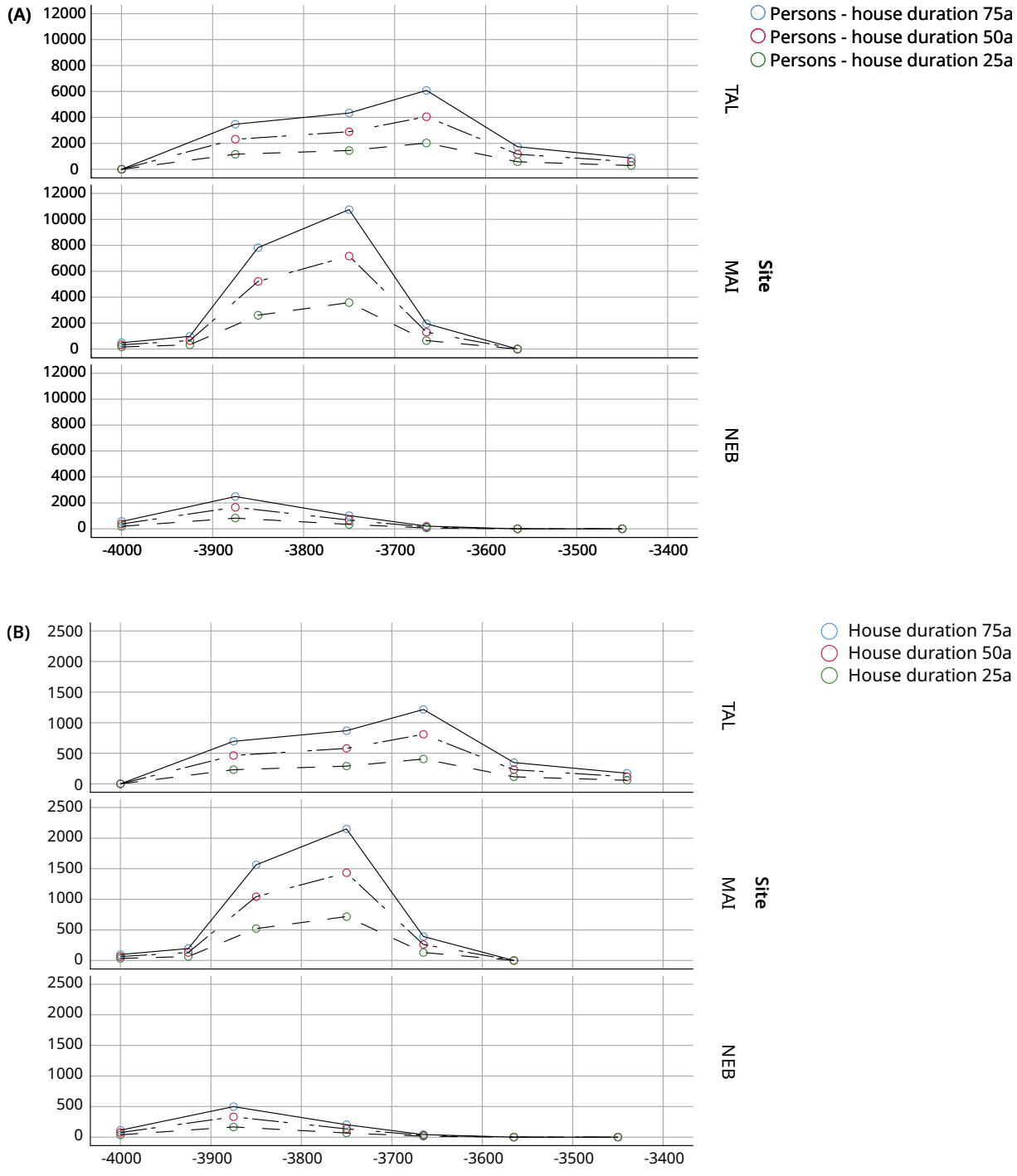


Figure 55. Occupation trends in Maidanetske, Nebelivka and Talianki over time (4000–3400 BCE): (A) absolute number of inhabitants (linear scale); (B) absolute number of contemporary houses; (C) absolute number of inhabitants (logarithmic scale).

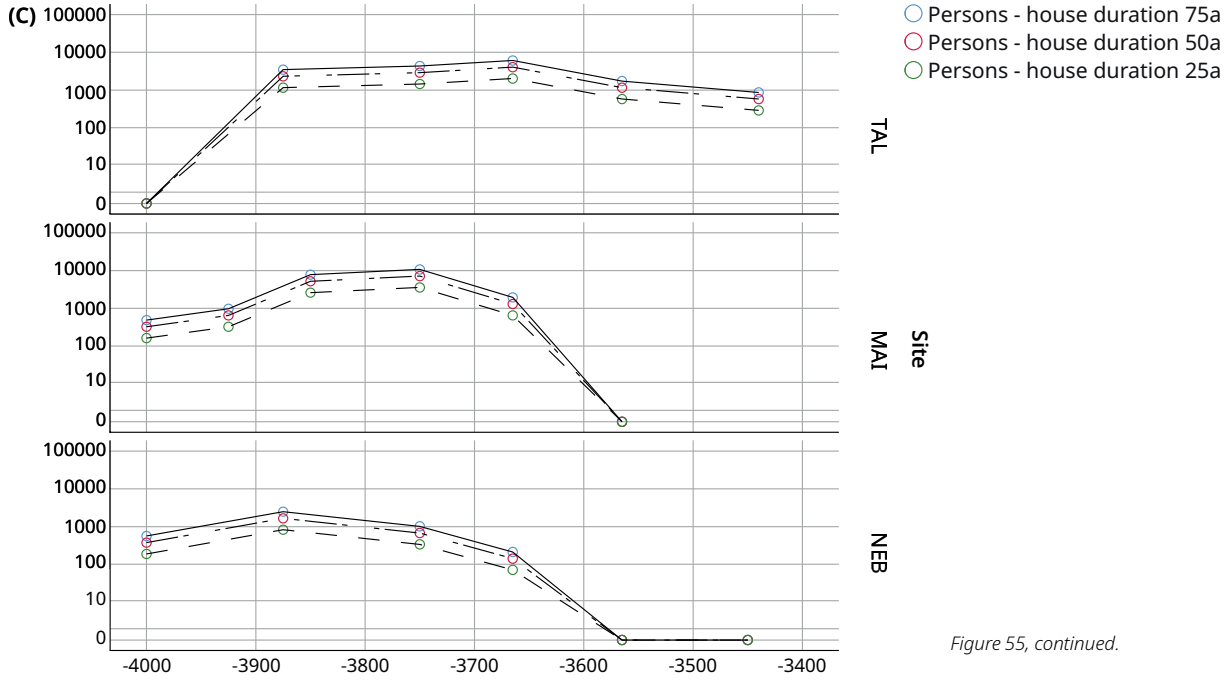


Figure 55, continued.

With the exception of B1/2, which seems to start about 150 years earlier in the west and the middle region than in the east, most of the other Trypillia phases started more or less contemporaneously.

Discussion and consequences

The investigation and analysis of ^{14}C data from Trypillia sites have above all also shown the potential for internal structuring of settlement dynamics in the individual settlements. Thus, with sufficient ^{14}C dates, it is possible to evaluate the local settlement developments, but also those of mega-sites in relation to each other. As a result, the settlement biographies are basically similar, but also variable per site, *e.g.* with regard to population trends. For example, while Maidanetske and Talianki show an increasingly dense settlement, the 'large' settlement Nebelivka breaks off quite early. Accordingly, the number of inhabitants in this mega-site is rather low and comparable to those of larger medium-sized settlements (Stolniceni).

In the four settlements where an internal subdivision was possible due to the extent of the study and the number of ^{14}C dates, an increasing occupation of the inner space, *i.e.* increasingly from the outside to the inside, could be observed.

At the household level, approximations of the lifespan of houses could be evaluated. Even though strong variations can be observed, the average lifespan of a house stabilises at 40–50 years. Where observable (Maidanetske and Talianki), there are indications of an increase in the lifespan of houses the later they are built. This could be explained by a certain scarcity of resources.

On a typochronological level, it could be shown that a continuity from PCC 3/1 to C1 is demonstrable in the 'west', whereas this is not the case in the central and eastern Trypillia test regions. Obviously, especially Trypillia B1/2 commences about 150 years earlier in the west and in the middle region than in the east. Trypillia B2 and C1, on the other hand, appear more or less simultaneously from west to east, tending to appear even slightly earlier in the east. Possibly, we are thus made aware of the spread of new concepts (according to Harper *et al.* 2023 on the intensive agrarian mode of production) from west to east and then innovative processes in

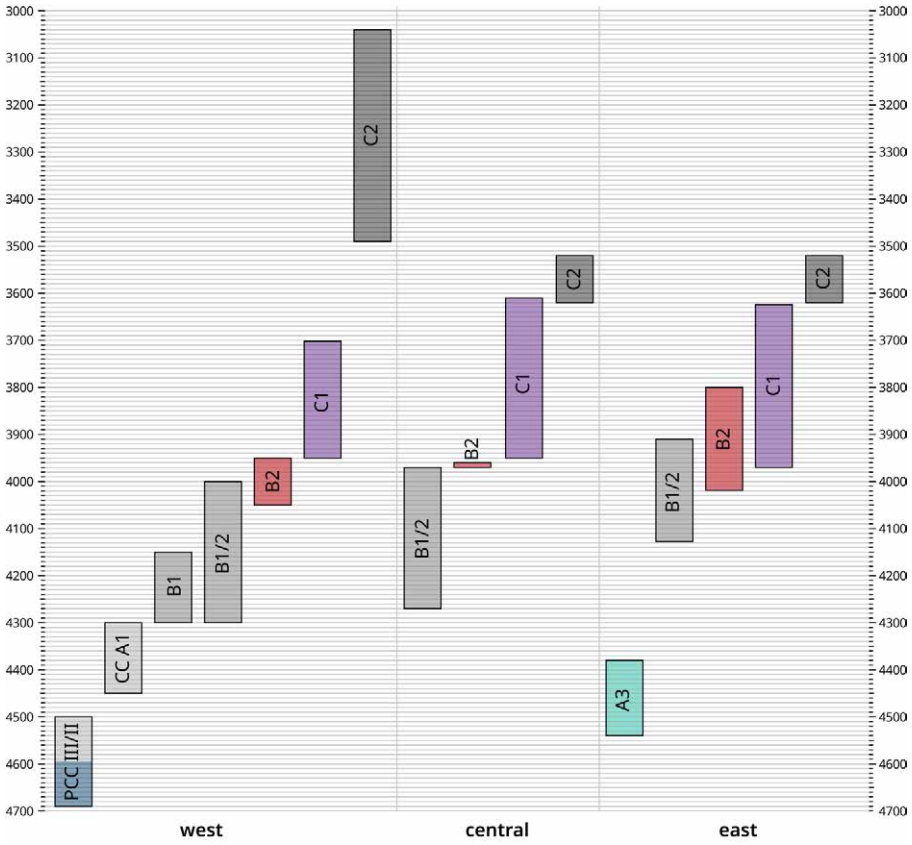


Figure 56. The comparison of the dating of phases BCE from the Middle-Dniester region, Southern Bug-Dniester interfluve, and the Southern Bug-Dnieper interfluve.

the former marginal areas of the east, which also influence the west. The changes towards Trypillia C2 could also spread from east to west. Thus, if we initially recognise a fundamentally open communication system in which, in particular around 4300–4130 BCE, new – also economic – impulses reach the east from the west and in which the new mega-site principles spread relatively simultaneously, it is the diversifications around 3620–3500 BCE that contribute to the dissolution of the larger structures from east to west.

The decisive gain of the investigations carried out here, however, is above all to allow detailed statements on settlement processes at the level of settlements. This makes it easier to divide settlements into phases, which help to answer economic, demographic and political or social questions in a much more condensed way.

Supplementary materials

The supplementary materials are freely available online under a CC BY 4.0 licence, in the Kiel University research data repository opendata@uni-kiel.de: https://doi.org/10.57892/100-55

Supplement 1. List of Trypillia ^{14}C data.
Supplement 2. Oxcal files, additional figures and data collections.
Supplement 3. Nebelivka. Classified radiocarbon dates.
Supplement 4. Calculated house durations.

References

Albert, B., Innes, J. and Kremenetskiy, K., Millard, A.R., Gaydarska, B., Nebbia, M. and Chapman, J., 2020. What was the ecological impact of a Trypillia megasite occupation? Multi-proxy palaeo-environmental investigations at Nebelivka, Ukraine. *Vegetation History and Archaeobotany,* 29, 15–34. Available from: DOI:10.1007/s00334-019-00730-9

Bronk Ramsey, C., 1994. Analysis of chronological information and radiocarbon calibration: the Program OxCal. *Archaeological Computing Newsletter*, 41, 11–16.

Bronk Ramsey, C., 2009a. Bayesian Analysis of Radiocarbon Dates. *Radiocarbon,* 51 (1), 337–360. Available from: DOI:10.1017/S0033822200033865

Bronk Ramsey, C., 2009b. Dealing with Outliers and Offsets in Radiocarbon Dating. *Radiocarbon*, 51 (3), 1023–1045. Available from: DOI:10.1017/S0033822200034093

Bronk Ramsey, C., 2017. Methods for Summarizing Radiocarbon Datasets. *Radiocarbon*, 59 (6), 1809–1833. Available from: DOI:10.1017/RDC.2017.108

Diachenko, A., 2016. Demography Reloaded. *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE.* Themes in Contemporary Archaeology 2. London, New York: Routledge, 181–193. Available from: DOI:10.4324/9781315630731

Draşovean, F. and Schier, W., 2010. The Neolithic tell sites of Parţa and Uivar (Romanian Banat). A comparison of their architectural sequence and organisation of social space. *In*: S. Hansen, ed. *Leben auf dem Tell als soziale Praxis. Beiträge des Internationalen Symposiums in Berlin vom 26.–27. Februar 2007*. Kolloquien zur Vor- und Frühgeschichte 14. Bonn: Dr. Rudolf Habelt, 165–187.

Dreibrodt, S., Hofmann, R., Sipos, G., Schwark, L., Videiko, M., Shatilo, L., Martini, S., Saggau, P., Bork, H.-R., Kirleis, W., Duttmann, R. and Müller, J., 2020. Holocene soil erosion in Eastern Europe-land use and/or climate controlled? The example of a catchment at the Giant Chalcolithic settlement at Maidanetske, central Ukraine. *Geomorphology*, 367, 107302. Available from: DOI:10.1016/j.geomorph.2020.107302

Dury, J., 2021. *Dealing With Reservoir Effects in Human and Faunla Skeletal Remains. Understanding the radiocarbon dating of aquatic samples*. Theses and Papers in Scientific Archaeology 20. Stockholm: Stockholm University. Available from: http://urn.kb.se/resolve?urn=urn:nbn:se:su:diva-189708

Fuchs, K., Hofmann, R., Shatilo, L., Schlütz, F., Storch, S., Chabanyuk, V., Kirleis, W. and Müller, J., 2023. Life and death in Trypillia times: Interdisciplinary analyses of the exceptional human remains from the settlement of Kosenivka, Ukraine (3700–3600 BCE). PLOS One. Available from: DOI:10.1371/journal.pone.0289769

Gaydarska, B., ed., 2020. *Early Urbanism in Europe. The Trypillia Megasites of the Ukrainian Forest-Steppe*. Warsaw, Berlin: De Gruyter. Available from: DOI:10.1515/9783110664959

Gaydarska, B., and Chapman, J., 2022. *Megasites in Prehistoric Europe. Where Strangers and Kinsfolk Met*. Cambridge Elements: The Archaeology of Europe. Cambridge: Cambridge University Press. Available from: DOI:10.1017/9781009099837

Gaydarska, B., Nebbia, M. and Chapman, J., 2020a. The Test Pits. *In:* B. Gaydarska, ed. *Early Urbanism in Europe. The Trypillia Megasites of the Ukrainian Forest-Steppe*. Warsaw, Berlin: De Gruyter, 214–228. Available from: DOI:10.1515/9783110664959-008

Gaydarska, B., Nebbia, M., Videiko, M. and Chapman, J., 2020b. The Mega-Structure. *In:* B. Gaydarska, ed. *Early Urbanism in Europe. The Trypillia Megasites of the Ukrainian Forest-Steppe*. Warsaw, Berlin: De Gruyter, 194–211. Available from: DOI:10.1515/9783110664959-008

Hale, D., 2020. Geophysical Investigations and the Nebelivka Site Plan. *In:* B. Gaydarska, ed. *Early Urbanism in Europe. The Trypillia Megasites of the Ukrainian Forest-Steppe*. Warsaw, Berlin: De Gruyter, 122–148. Available from: DOI:10.1515/9783110664959-008

Harper, T.K., Diachenko, A., Ryzhov, S.N., Rassamakin, Y.Y., Eccles, L.R., Kennett, D.J. and Tsvek, E.V., 2023. Assessing the spread of Eneolithic agricultural communities in the forest-steppe of Ukraine using AMS radiocarbon dating. *Radiocarbon*, 65 (3), 643–663. Available from: DOI:10.1017/RDC.2023.28

Hofmann, R. and Shatilo, L., 2022. Tripolye population aggregation and dispersal in light of regional settlement trajectories. *In*: M. Dębiec, J. Gorski, J. Müller, M. Nowak, A. Pelisiak, T. Saile and P. Włodarczak, eds. *From Farmers to Heroes? Archaeological Studies in Honor of Sławomir Kadrow*. Universitätsforschungen zur prähistorischen Archäologie 376. Bonn: Dr. Rudolf Habelt, 197–212.

Hofmann, R., Müller, J., Shatilo, L., Videiko, M., Ohlrau, R., Rud, V., Burdo, N., Dal Corso, M., Dreibrodt, S. and Kirleis, W., 2019. Governing Tripolye: Integrative architecture in Tripolye settlements. *PLoS ONE*, 14 (9), e0222243. Available from: DOI:10.1371/journal.pone.0222243

Kruts *et al.* 2005: Круц, В.А., Корвин-Пиотровский, А.Г., Рыжов, С.Н., Бузян, Г.Н., Овчинников, Э.В., Черновол, Д.К. and Чабанюк, В.В., eds., 2005. Исследование поселений-гигантов трипольской культуры в 2002-2004 гг. Киев: Институт археологии НАН Украины.

Makarewicz, C.A., Hofmann, R., Videiko, M.Y. and Müller, J., 2022. Community negotiation and pasture partitioning at the Trypillia settlement of Maidanetske. *Antiquity*, 96 (388), 831–847. Available from: DOI:10.15184/aqy.2022.32

Millard, A., 2020. The AMS Dates. *In*: B. Gaydarska, ed. *Early urbanism in Europe. The Trypillia megasites of the Ukrainian forest-steppe*. Warsaw, Berlin: De Gruyter, 246–256. Available from: DOI:10.1515/9783110664959-008

Miller, D., 2020. The Molluscan Evidence. *In:* B. Gaydarska, ed. *Early Urbanism in Europe. The Trypillia Megasites of the Ukrainian Forest-Steppe*. Warsaw, Berlin: De Gruyter, 119–120. Available from: DOI:10.1515/9783110664959-008

Mischka, C., Preoteasa, C. and Schafferer, G., 2019. Gradiometerprospektionen auf Fundplätzen der Cucuteni-Kultur im Kreis Neamţ (Rumänien). Ergebnisse der Jahre 2015 und 2016. *Eurasia Antiqua*, 22 (2016), 115–131.

Müller, J., Hofmann, R., Brandtstätter, L., Ohlrau, R. and Videiko, M., 2016a. Chronology and Demography: How Many People Lived in a Mega-Site? *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE.* Themes in Contemporary Archaeology 2. London, New York: Routledge, 133–170. Available from: DOI:10.4324/9781315630731

Müller, J., Rassmann, K. and Videiko, M., eds., 2016b. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE.* Themes in Contemporary Archaeology 2. London, New York: Routledge. Available from: DOI:10.4324/9781315630731

Müller, J., Hofmann, R., Kirleis, W., Dreibrodt, S., Ohlrau, R., Brandtstätter, L., Dal Corso, M., Out, W., Rassmann, K., Burdo, N. and Videiko, M., eds., 2017. *Maidanetske 2013. New excavations at a Trypillia mega-site* / Майданецьке *2013.* Нові розкопки великого Трипільського поселення. Studien zur Archäologie in Ostmitteleuropa 16. Bonn: Dr. Rudolf Habelt.

Müller, J., Hofmann, R., Videiko, M. and Burdo, N., 2022. Nebelivka – rediscovered: A Lost City. *In*: M. Dębiec, J. Gorski, J. Müller, M. Nowak, A. Pelisiak, T. Saile and P. Włodarczak, eds. *From Farmers to Heroes? Archaeological Studies in Honor of Sławomir Kadrow*. Universitätsforschungen zur prähistorischen Archäologie 376. Bonn: Dr. Rudolf Habelt, 213–222.

Nebbia, M., Gaydarska, B., Millard, A. and Chapman, J., 2018. The making of chalcolithic assembly places: Trypillia megasites as materialized consensus among equal strangers? *World Archaeology*, 50 (1), 41–61. Available from: DOI:10.1080/00438243.2018.1474133

Ohlrau, R., 2020. *Maidanets'ke: Development and decline of a Trypillia mega-site in Central Ukraine*. Scales of Transformation in Prehistoric and Archaic Societies 7. Leiden: Sidestone Press. Available from: DOI:10.59641/h0912kt

Ohlrau, R., Dal Corso, M., Kirleis, W. and Müller, J., 2016. Living on the Edge? Carrying Capacities of Trypillian Settlements in the Buh-Dnipro Interfluve. *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE.* Themes in Contemporary Archaeology 2. London, New York: Routledge, 207–220. Available from: DOI:10.4324/9781315630731

Raczky, P., Füzesi, A., Rassmann, K., Höhler-Brockmann, H., Podgorelec, M. and Banffy, E., 2022. Neolithic settlement mounds in the southern Alföld (previous research and new investigations at Hódmezővásárhely-Kökénydomb). *In*: M. Dębiec, J. Gorski, J. Müller, M. Nowak, A. Pelisiak, T. Saile and P. Włodarczak, eds. *From Farmers to Heroes? Archaeological Studies in Honor of Sławomir Kadrow*. Universitätsforschungen zur prähistorischen Archäologie 376. Bonn: Dr. Rudolf Habelt, 255–277.

Rascovan, N., Sjögren, K.-G., Kristiansen, K., Nielsen, R., Willerslev, E., Desnues, C. and Rasmussen, S., 2019. Emergence and Spread of Basal Lineages of *Yersinia pestis* during the Neolithic Decline. *Cell*, 176 (1–2), 295–305. Available from: DOI:10.1016/j.cell.2018.11.005

Rassmann, K., Ohlrau, R., Hofmann, R., Mischka, C., Burdo, N., Videjko, M.Y. and Müller, J., 2014. High precision Tripolye settlement plans, demographic estimations and settlement organization. *Journal of Neolithic Archaeology*, 16, 96–134. Available from: DOI:10.12766/jna.2014.3

Rassmann, K., Mertl, P., Voss, H.-U., Bicbaev, V., Popa, A. and Musteață, S., 2016. Copper Age settlements in Moldova: Insights into a Complex Phenomenon from Recent Geomagnetic Surveys. *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE*. Themes in Contemporary Archaeology 2. London, New York: Routledge, 55–70. Available from: DOI:10.4324/9781315630731

Rassmann, K., Scholz, R., Mertl, P., Radloff, K., Pendić, J. and Jablanković, A., 2021. Belovode: geomagnetic data as a proxy for the reconstruction of house numbers, population size and the internal spatial structure. *In*: M. Radivojević, B.W. Roberts, M. Marić, J. Kuzmanović Cvetković. and T. Rehren, eds. *The Rise of Metallurgy in Eurasia. Evolution, Organisation and Consumption of Early Metal in the Balkans*. Oxford: Archaeopress, 94–107. Available from: DOI:10.32028/9781803270425

Reimer, P.J., Austin, W.E.N., Bard, E., Bayliss, A., Blackwell, P.G., Bronk Ramsey, C., Butzin, M., Cheng, H., Edwards, R.L., Friedrich, M., Grootes, P.M., Guilderson, T.P., Hajdas, I., Heaton, T.J., Hogg, A.G., Hughen, K.A., Kromer, B., Manning, S.W., Muscheler, R., Palmer, J.G., Pearson, C., van der Plicht, J., Reimer, R.W., Richards, D.A., Scott, E.M., Southon, J.R., Turney, C.S.M., Wacker, L., Adolphi, F., Büntgen, U., Capano, M., Fahrni, S.M., Fogtmann-Schulz, A., Friedrich, R., Köhler, P., Kudsk, S., Miyake, F., Olsen, J., Reinig, F., Sakamoto, M., Sookdeo, A. and Talamo, S., 2020. The IntCal20 Northern Hemisphere Radiocarbon Age Calibration Curve (0–55 cal kBP). *Radiocarbon*, 62 (4), 725–757. Available from: DOI:10.1017/RDC.2020.41

Rud, V., Hofmann, R., Kosakivskyi, V., Zaitseva, O. and Müller, J., 2019a. Trypillia Megasites West of the River Southern Buh: Preliminary Results of Bilyi Kamin Site Investigation in 2018. *Journal of Neolithic Archaeology*, 21, 27–60. Available from: DOI:10.12766/jna.2019.2

Rud, V., Zaitseva, O., Hofmann, R., Rauba-Bukowska, A. and Kosakivsky, V., 2019b. Unique Pottery Kiln Construction? The Interpretation of Massive Clay Objects from the Trostianchyk Site of the Trypillia Culture. *Sprawozdania archeologiczne*, 71, 11–39. Available from: DOI:10.23858/sa71.2019.001

Shatilo, L., 2021. *Tripolye Typo-chronology: Mega and Smaller Sites in the Sinyukha River Basin.* Scales of Transformation in Prehistoric and Archaic Societies 12. Leiden: Sidestone Press. Available from: DOI:10.59641/m5457py

Țerna, S., Rassmann, K., Vasilache, M. and Radloff, K., 2016. Stolniceni I – new research on a Cucuteni-Tripolye large site. *In*: A. Zanoci, E. Kaiser, M. Kashuba, Izbitser, E. and M. Băţ, eds. *Mensch, Kultur und Gesellschaft von der Kupferzeit bis zur frühen Eisenzeit im nördlichen Eurasien. Beiträge zu Ehren zum 60. Geburtstag von Eugen Sava / Man, Culture, and Society from the Copper Age until the Early Iron Age in Northern Eurasia. Contributions in Honour of the 60th Anniversary of Eugen Sava*. Tyragetia International 1. Chişinău: Bons Offices, 41–52.

Țerna, S., Vornicu-Țerna, A., Hofmann, R., Dal Corso, M., Shatilo, L., Vasilache-Curoşu, M., Rud, V., Knapp, H., Kirleis, W., Rassmann, K. and Müller, J., 2019. Stolniceni – Excavation results from the 2017 campaign. *Journal of Neolithic Archaeology*, 21, 209–282. Available from: DOI:10.12766/jna.2019.9

Uhl, R.A., Vasilache-Curoşu, M., Sîrbu, M., Sîrbu, L., Bicbaev, V., Steiniger, D., Zidarov, P., Sava, E. and Hansen, S., 2017. Petreni in der nördlichen Moldaurepublik. Bericht über die Ausgrabungen der Jahre 2011–2013. *Eurasia Antiqua,* 20 (2014), 185–206.

Videiko, M. and Burdo, N., 2020. Houses B17 and B18 and Their Pits. *In:* B. Gaydarska, ed. *Early Urbanism in Europe. The Trypillia Megasites of the Ukrainian Forest-Steppe*. Warsaw, Berlin: De Gruyter, 239–241. Available from: DOI:10.1515/9783110664959-008

20. Ring-shaped settlement plans and Trypillia population agglomeration

Robert Hofmann, Liudmyla Shatilo, Knut Rassmann, Vitalii Rud, Stanislav Ţerna†, Stefan Dreibrodt, Vladyslav Chabaniuk, Wiebke Kirleis, Johannes Müller

Abstract

This article is devoted to the topic of Trypillia ring-shaped settlements. It is based on a review of site layouts of 53 settlements. For this purpose, the settlement plans were divided into their components and analysed. On this base, questions were examined concerning the basic types of Trypillia sites, their chronological development and spatial specificity. In addition, topics were raised regarding the planning of such sites and social transformations, which can be traced due to the maps of the villages. The results of the study offer an alternative understanding of both Trypillia sites and the 'mega-site' phenomenon.

Introduction

Around 4200 BCE, a new, unusual type of settlement appears in the territory between Prut and Dnieper associated with the Trypillia cultural phenomenon (4700–3000 BCE). About 1000 sites that fall within these chronological boundaries are known from this zone. Many of the settlements that have a sufficient level of investigations show a quite unique settlement layout. The exclusivity of this layout lies in the organisation of the living space around a *ring-corridor* or *ring-street*, which so far has no analogies, and specific public architecture. Some of such sites have a rather large size (up to 320 ha), and correspondingly a large number of houses, which testifies to processes of population agglomeration. More than one generation of researchers is working on the problem of understanding these villages (*e.g.* Menotti and Korvin-Piotrovskiy 2012; Zbenovič 1996; Müller *et al.* 2016c; Videiko and Rassmann 2016).

Intensive research by Soviet, Ukrainian and recently also some western and central European archaeologists has led to the insight that the settlements

mentioned are the result of thorough planning and that in these settlement plans the social configuration of Trypillian societies is encoded in a specific and unique way (Shmagliy and Videiko 2001–2002; Kruts 2012).

Thanks to the work of the last 10 years with the participation of several teams, a number of new high-resolution magnetic plans have been achieved, some of which are published (Kruts *et al.* 2013; Chapman *et al.* 2014a; Rassmann *et al.* 2014; Rassmann *et al.* 2016b; Hofmann *et al.* 2016b; Mischka *et al.* 2016; Țerna *et al.* 2016; Rud *et al.* 2019a; Țerna *et al.* 2019) and some are presented in this work. This enlarged database significantly expands the possibilities for studying Trypillian sites in general, and their special layout in particular. From the above-mentioned Trypillia settlement plans, an excellent source for social archaeological investigations is available, which is almost unique in European prehistory.

A quick look at the available data has already shown that so far there is no clear typology of the Trypillia-Cucuteni sites. And this is not accidental, because to realise all the specific aspects of the settlement layouts a certain time is needed. In addition, the annually increasing database makes repeated adjustments necessary.

In this article, it is suggested that the settlement layouts under consideration should be divided into 'Cucuteni' and 'Trypillia' layouts, followed by their further subdivision into subtypes. The legitimacy and relevance of such a division and questions regarding the time and context of the emergence of a particular type of site will be considered in the discussion part of this article. The main emphasis here is directed towards the consideration of the Trypillia layout based on the *ring-corridor* or *ring-street*. In contrast, settlements of the Cucuteni type have not been systematically included in this chapter.

This contribution is without doubt only one of the attempts to systematise the new data, and a number of topics will need to be clarified in further studies.

Research questions and aims of the work

The main aim of this chapter is to discuss the emergence and development of the very specific *concentric Trypillia settlement layout* and the integrated analysis of the components in a long-term and interregional perspective. This concept is based on the comprehension of new materials obtained as a result of work carried out in recent years and and their integration into existing databases, which are mostly quite recent as well.

It should be noted that the tradition of mapping Trypillia settlements with the use of scientific methods is not new. Its origins can be traced back to 1967, when several specialists began to use geophysical methods to determine objects on Trypillian sites. The geophysicists G. F. Zagny and O. M. Rusakov used the M-20 proton magnetometer to determine the location of Trypillian time objects, the pits on the site near Chapaevka (not far from Kiev) and *ploshchadkas* at the settlement of Starie Bezradichi (Zagny *et al.* 1971). Since the results of magnetic prospection were quite positive, the extraordinary effectiveness of the method was clearly demonstrated.

In the same year, another geophysicist, V. P. Dudkin, during the Dniester-Danube expedition, examined a number of archaeological sites, including a ditch on the Mayaki site (Dudkin 1968). In this case, electrical resistivity measurements (geoelectrics) were conducted, which also showed quite accurately the location of objects from Trypillian times. Later on, this method turned out to be less in demand.

Later, archaeomagnetic surveys were carried out on a large scale on a large number of Trypillian sites located within the borders of modern Moldova and Ukraine (works by Dudkin, Zagniy, Rusakov and Golub). Regarding the number of sites for which plans were made, Koshelev (2004, 6) mentioned a number of 40 sites that were fully examined in Ukraine. However, there is no complete catalogue of settlements

investigated by magnetic surveys. Very surprisingly, the results of the magnetic surveys (*e.g.* maps) were generally only published occasionally and unsystematically (mainly the very well-known plans of Talianki and Maidanetske). This gap was partially filled with various articles in the *Encyclopedia of Trypillia civilization* (Videiko and Burdo 2004) and the monograph of Koshelev (2004). However, these publications do not contain all settlement plans either. Some kind of paradox could be observed: such plans were often used only for the 'working process' (*e.g.* when conducting excavations, or analysis on the population density). This is truly surprising, especially when taking into account that obtaining maps in this way was an extremely time- and labour-consuming process. As a result, materials that were not published on time have largely lost their relevance, especially for modern investigations.

Nevertheless, the importance of the application of archaeomagnetometry and other geophysical methods for research on Trypillian settlements is difficult to overestimate. Embedded into very intensive archaeological research, extensive application of the new methods led to extremely important achievements and to a completely new scientific level of understanding (cf. Chapman *et al.* 2014b). Aside from targeted excavations, these applications made it possible, for example, to identify the main components and zones of Trypillia settlement plans and to perform substantiated estimates of population sizes (Kruts 1989; Ohlrau 2015; Diachenko 2016; Müller *et al.* 2016a).

Since the end of the first decade of the 21st century, a new stage has begun in the compilation of magnetic plans of Trypillia settlements (*e.g.* Chapman *et al.* 2014b; Rassmann *et al.* 2016a; Țerna 2016). The differences between these new plans and previous ones is that improved equipment allows a much more accurate picture of settlement layouts to be achieved. So whereas on earlier plans the main anomalies that were identified mainly originated from standard houses (the remains of which consist of burnt clay blocks), on new maps it is additionally possible to detect anomalies of a different nature, which are interpreted as pits of various sizes, pottery kilns, ditches, paths, *etc.* The modern magnetograms are thus much more accurate.

More than half of the settlement plans analysed in this contribution were newly obtained through a collaborative research framework, which includes the Roman Germanic Commission Frankfurt a. M. of the German Archaeological Institute, the High Anthropological School Chisinau, the National Academy of Sciences of Ukraine, the Borys Grinchenko Kyiv University and Kiel University.

No less important for a significantly improved understanding of Trypillian societies is the achievement of obtaining about 350 new radiocarbon dates through the above-mentioned research framework, which allows the clarification of the chronology of these sites (Müller *et al.* 2016a; Chapman *et al.* 2018; Uhl *et al.* 2014; Chapter 19, this work, Vol. II). In addition, the development and application of new research and sampling strategies and scientific methods should be mentioned (Chapman *et al.* 2014b; Müller *et al.* 2018; Hofmann *et al.* 2018).

Thus, this updated database is an exceptional source for exploring the Trypillian period. In particular, it offers a unique opportunity to explore questions on population dynamics and social organisation. In this study, we would like to focus on the following research questions:

1. What were the baselines and the development of Cucuteni-Trypillia settlement plans in a spatio-temporal perspective?
2. Which basic types of Cucuteni-Trypillia settlement layouts exist?
3. When, where and under what circumstances do the specific concentric settlement layouts appear for the first time in Trypillia contexts? How is this related to the emergence of Trypillia mega-sites? Were there forerunners elsewhere?
4. What can all this tell us about the nature of the Trypillia mega-site phenomenon? To what extent were Cucuteni-Trypillia settlements planned and what social transformations can be deduced from the development of the settlement plans?

plan-id	site	year	country	study region	relative chronology	publication	latitude	longitude	Site size (total, ha)	area scanned (%)	median width ring corridor (m)
1	Apolianka	2014	UKR	A	Trip. C2	Rassmann *et al.* 2014	48.728792	30.424514	≈21	100	
2	Chyzhivka	2017	UKR	A	Trip. B1	unpublished	49.156769	30.703630	≈20	65	55.2
3	Dobrovody	2011	UKR	A	Trip. C1	Rassmann *et al.* 2014	48.762810	30.378585	≈210	11	150.3
4	Grebenyukiv Yar	2013–2014	UKR	A	Trip. A	unpublished	48.818931	30.717620	≈3.3	55	
5	Hlybochok	2016	UKR	A	Trip. B2	Ohlrau/Rud 2019	48.885519	30.791126	≈130	8.4	108.5
6	Kosenovka	2016	UKR	A	Trip. C1	unpublished	48.822377	30.403349	≈80	8.6	127
7	Maidanteske A	2011	UKR	A	Trip. C1	Rassmann *et al.* 2014, Ohlrau 2015 and in press, Müller *et al.* 2018	48.804105	30.685547	>10	100	89.3
8	Maidanetske B	2011–2016	UKR	A	Trip. C1	Rassmann *et al.* 2014, Ohlrau 2015 and 2019, Müller *et al.* 2018	48.804105	30.685547	≈200	82	87.4
9	Moshuriv 1	2016	UKR	A	Trip. C1	Ohlrau/Rud 2019	48.897648	30.545502	≈7	100	49.15
10	Moshuriv 2	2016	UKR	A	Trip. C2	Ohlrau/Rud 2019	48.851714	30.592305	3.6	100	
11	Moshuriv 3	2016	UKR	A	Trip. C2	Ohlrau/Rud 2019	48.897648	30.545502	≈0.3	100	
12	Nebelivka	2009–	UKR	A	Trip. B2	Chapman *et al.* 2014	48.640990	30.557135	230	100	80.5
13	Rohy	2016	UKR	A	Trip. C2	Ohlrau/Rud 2019	48.853123	30.493551	6.35	100	
14	Talianki	2011–2012	UKR	A	Trip. C1	Rassmann *et al.* 2014, Ohlrau 2015	48.801938	30.534719	320	55	86.9
15	Talne 3	2016	UKR	A	Trip. C1	Ohlrau/Rud 2019	48.856901	30.734783	1.2	100	
16	Volodymyrivka	2017	UKR	A	Trip. B2	unpublished	48.562180	30.749858	≈95	25	77.5
17	Veselyj Kut	2017	UKR	A	Trip. B1-B2	unpublished	48.970509	30.623021	≈60	50	66.7
18	Bernashivka 1	Excavation	UKR	B	Trip. A	Черновол 2016	48.566667	27.466667	≈0.12	100?	
19	Bilyi Kamin	2018	UKR	B	Trip. C1	Rud *et al.* 2019	48.266356	29.397327	≈100	40	116.2
20	Gariachkivka 2	2017	UKR	B	Trip. C2	see Chapter 14, this work, Vol. II	48.296604	28.713492	≈0.3	?	
21	Gariachkivka 3	2018	UKR	B	Trip. B1-B2	see Chapter 14, this work, Vol. II	48.339620	28.768158	≈8.5	45	43.65
22	Gariachkivka 7	2018	UKR	B	Trip. B1-B2	see Chapter 14, this work, Vol. II	48.315886	28.768548	≈9.9	25	
23	Gariachkivka 8	2018	UKR	B	Trip. B1-B2	see Chapter 14, this work, Vol. II	48.313428	28.765528	≈7.7	100	33.1
24	Kisnytsia	2018	UKR	B	Trip. C1/C2	see Chapter 14, this work, Vol. II	48.429820	28.757950	6.75	100	
25	Krynychky	2017	UKR	B	Trip. C2	see Chapter 14, this work, Vol. II	48.411778	28.747999	≈14	≈50	
26	Ternivka	2017	UKR	B	Trip. B1-B2	see Chapter 14, this work, Vol. II	48.416875	28.862549	≈8	80	39
27	Trostianchyk	2016	UKR	B	Trip. B2	Рудь *et al.* 2016	48.527579	29.347463	3	100	

length of the ring corridor (m)	central plaza shape	central plaza dimension 1 (m)	central plaza dimension 2 (m)	number of houses (all categories)	general layout	shape	main Plaza (location)	ditch	number of ^{14}C dates	dating range BCE (highest probability)
	-			31	unrelated ring-sections + house groups	amorphous	-	-	2	3685/3710–3625/3565
≈1115	trian.	130	77	119	concentric	round	?	2	3	4040–3940
	-			293	concentric	oval	?	-	6	3800–3680
	-			10	unimodal NE-SW orientation	?	-	-	6	4540–4450
3085	rect.	125	165	99	concentric	oval	NNE	2?	-	
	-			49	concentric	oval	?	1	12	3700–3650
	-			66	concentric	oval?	?	-	9	3935–3700
3620	rect.	≈130	160	2254	concentric	oval	ENE	2	90	3960–3640
675	rect.	47	85	90	concentric	round	ENE	-	3	3850–3650
	-			31	unrelated ring-sections + house groups	two intertwined house rings	no	-		3695–3620
	-			7	inconsistently organised house group	amorphous	no	-	-	
5076	rect.	70	90	1446	concentric	irregular oval	ENE	1–3	94	3960–3770
	-			18	concentric/unrelated ring sections	oval	?	-	-	3670/3650–3615
6680	-			1400	concentric	oval	?	-	43	3800–3650
>395	?			21	concentric	round	centre or NE	-	-	3790–3700
	rect.	240	150	455	concentric	oval	ENE	-	2	3930–3800
	trian.	250	135	298	concentric	cloverleaf-shaped	ESE	1	8	4075–4000
	-			16	bimodal NW-SE and N-S orientation	amorphous	-	-	5	4660–4250
2816	rect.	≈250	400	429	concentric	irregular oval	NE	-	9	3920–3790
	-			0	no anomalies visible	-		-	-	-
	undef.	≈60	≈60	44	concentric	round	E or ENE	-	-	under excavation
	undef.	≈39	?	31	concentric	round	NW?	-	-	under excavation
560	undef.	42	≈38	132	concentric	round	NE	1	-	under excavation
	?			73	unrelated ring-sections + house groups	2 irregular round + 1 inconsistently organised house group	-	-	3	3570–3430
	-			≈50	unrelated ring-sections + house groups	2 irregular round	?	-	5	3580–3530
638	undef.	75	48	59	concentric	round	ESE	-	2	4220–3990
	trian.	38–67	47	50	rows & radii + ring-section	triangular spur	NNE	2	15	3980–3960

plan-id	site	year	country	study region	relative chronology	publication	latitude	longitude	Site size (total, ha)	area scanned (%)	median width ring corridor (m)
28	Vilshanka	2017	UKR	B	Trip. B1-B2	see Chapter 14, this work, Vol. II	48.212504	28.598318	25.5	75	57.3
29	Viitivka	2016	UKR	B	Trip. C1	Ohlrau/Rud 2019	48.452057	29.504841	50	20	84
30	Voroshylivka	2017	UKR	B	Trip. B2	Rud *et al.* 2021	49.067363	28.312236	5	5	
31	Zabolotne	2017	UKR	B	Trip. B1-B2	see Chapter 14, this work, Vol. II	48.421087	28.865429	37.5	78	62.4
32	Adâncata A	2015	RO	C	Cuc. A-B1	Hofmann *et al.* 2016a	47.758788	26.285891	1.85	100	
33	Adâncata B	2015	RO	C	Trip. B1	Hofmann *et al.* 2016a	47.758788	26.285891	0.78	100	
34	Baia	2015	RO	C	Trip. A	Hofmann *et al.* 2016a	47.417306	26.217246	1.95	100	
35	Cunicea 1	2016	MD	C	Trip. C2	unpublished	47.904395	28.674546	0.8	100	
36	Cunicea 3	2016	MD	C	Trip. C2	unpublished	47.906661	28.665817	5.6	100	
37	Cunicea 4	2016	MD	C	Trip. C2	unpublished	47.941819	28.644464	2.3	?	
38	Ghelăiești-*Dealul Nedeea*	2016	RO	C	Cuc A, A/B, B	Mischka *et al.* 2016 (2019)	46.950672	26.661654	7	100	
39	Gordinești II-*Stînca goală*	2017	MD	C	Trip. C2	Przybyła *et al.* 2017	48.140069	27.159606	2.26	100	
40	Putinești 3	2016	MD	C	Trip. B1	Hofmann *et al.* 2016b	47.859293	28.077206	7	100	
41	Scânteia-*Dealul Bodești*		Ro	C	Cuc A_3	Mischka *et al.* 2016	46.914333	27.582224	6–7	90	
42	Stolniceni 1	2015–2017	MD	C	Trip. B2/C1	Țerna *et al.* 2016	48.018476	27.336323	33	100	39.5
43	Trinca	2016	MD	C	Trip. C1	Hofmann *et al.* 2016b	48.210259	27.114537	14	50	26
44	Războieni–*Dealul Mare/ Dealul Boghiu* A	2016	RO	C	Cuc. A	Asăndulesei 2017	47.254796	27.037795	1.7	53	
45	Războieni–*Dealul Mare/ Dealul Boghiu* B	2016	RO	C	Cuc. A	Asăndulesei 2017	47.254796	27.037795	1.8	100	
46	Ripiceni-*Holm*	2012–2016	RO	C	Cuc. A-B_1	Boghian *et al.* 2016	47.955323	27.151524	6	100	
47	Sîngerei-*La Cazasu*	2010	MD	C	Cuc. A-B_1	Rassmann *et al.* 2016	47.676858	28.145777	9	100	
48	Sofia-*La Moină* I	1970s/80s	MD	C	Trip. B2/C1	Țerna 2016, 215, Fig. 31	48.099590	27.780267	7.5	100	
49	Sofia-L*a Moină* II	1970s/80s	MD	C	Trip. B2/C1	Țerna 2016, 215, Fig. 31	48.110015	27.789203	8	100	
50	Petreni I	2009–2011?	MD	C	Trip. C1	Rassmann *et al.* 2016	47.916771	27.876372	25	100	32.6
51	Brătești-*Dealul Chicerea*	Unknown	Ro	C	Cuc. B	Asăndulesei 2017	47.183670	26.707756	≈5	20	
52	Hăbășești-*Holm*	Excavation	Ro	C	Cuc. A3	Dumitrescu 1963	47.156373	26.957983	2	100	
53	Trușești-*Țuguieta*	Excavation	Ro	C	Cuc. A (+B)	Petrescu-Dîmbovița *et al.* 1999	47.750000	27.016666	2.4	100	

Table 1. Basic information and measurements of the Trypillia sites investigated in this contribution (cf. Fig. 1).

Materials and methods

The main source for this paper are 53 Cucuteni-Trypillia settlement plans obtained by high resolution magnetic surveys or large-scale excavations (Tab. 1; Plans A1–C1). In the majority of these settlements, basic characteristics such as size, shape, location of pits and ditches and the arrangements and density of houses are clearly detectable thanks to the burnt remains of houses and the general excellent contrast in the loess soils substrate (Pickartz *et al.* 2019).

length of the ring corridor (m)	central plaza shape	central plaza dimension 1 (m)	central plaza dimension 2 (m)	number of houses (all categories)	general layout	shape	main Plaza (location)	ditch	number of ^{14}C dates	dating range BCE (highest probability)
740	undef.	60	55	103	concentric	triangular spur	ENE	1	6	4220 –4050
2080	rect.	125	110	41	concentric	oval	-	-	6	3770–3640
	-			-	rows + radii + ring-section?	elongated spur	-	1	-	
1555	trian.	115	110	396	concentric	round	NE	-	7	4230–3990
	rect.	15	100	?	uniform ENE-WSW orientation	elongated spur		2?	-	
	-			30	centripetal	round		-	-	
	?			>10	?	round		2	-	
	-			6	single (?) house row			-	1	3490–3337
	-			66	unrelated ring sections + house groups	two intertwined house rings		-	-	
	-			8				-	1	3335–3211
	rect.	93	52	160	rows + radii + ring section	triangular spur	SSE	1+2	-	
	-							1	-	
	-							1	1	4330–4230
				60	uniform E-W orientation	rectangular	-	3	2	4320/4250-4200
1160	rect.	50	100	334	concentric	round		3	37	3950–3700
				112	concentric	oval		1	1	3800–3700
				30	uniform NE-SW orientation	triangular spur		3	-	
				25	uniform NE-SW orientation	rectangular		3	-	
	rect.	50	75	135	multimodal NE-SW, NW-SE			-		4035–3965
				125	unrelated ring-sections + house groups	irregular	-	-		
								-		
								-		
933	rect.	34	74	489	concentric	round		2	9	3950 –3700
					uniform E-W orientation	triangular spur		3		
				41	uniform NE-SW orientation	irregular spur		2	1	4251–4051
	rect.	35	36	96	Multimodal E-W, N-S, NE-SW, NW-SE	triangular spur				

The settlements investigated are distributed across three study regions between the eastern Carpathian foothills in the West and Ros and Dnieper rivers in the East: in the Dnieper-Southern Bug interfluve 17 (study region A), in the Southern Bug-Dniester interfluve 14 (study region B) and between Dniester and Carpathians 22 (Study region C; Fig. 1).

The chronology of the analysed settlement plans is based on accepted relative chronologies of the Cucuteni-Trypillia cultural complex (Schmidt 1932; Passek 1949; Dumitrescu 1963; Vinogradova 1972; Vinogradova 1973; Dumitrescu 1972). Systematic excavations or test trenches investigated several newly surveyed sites in order to

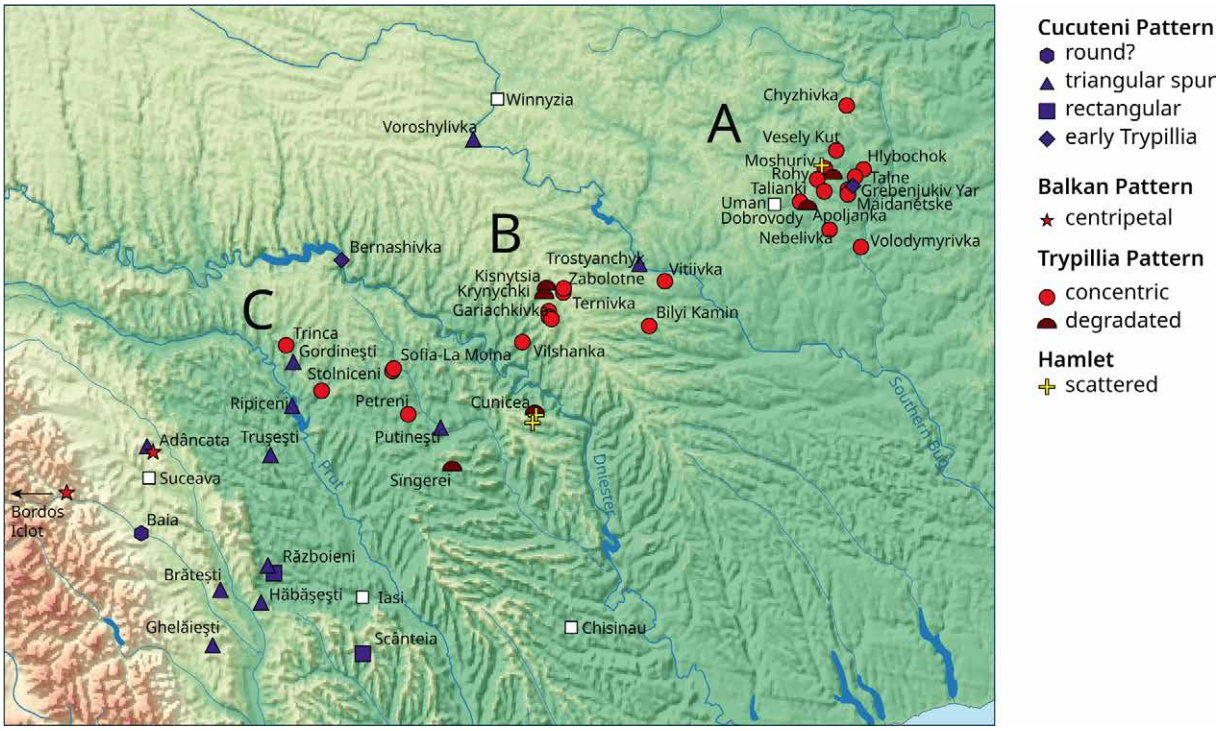


Figure 1. Geographical distribution and types of investigated sites in the three study regions. (A) Southern-Bug-Dnieper interfluve. (B) Southern Bug-Dniester interfluve. (C) Prut-Dniester interfluve and Carpathian foothills.

obtain archaeological material for typo-chronological analysis, scientific analysis and radiometric dating. The numerical chronology of these settlements was recently analysed in detail by Bayesian modelling of a large series of newly obtained ^{14}C dates (Müller *et al.* 2016a; Chapman *et al.* 2018; Ohlrau 2020; Rud *et al.* 2019a; Țerna *et al.* 2019; Harper *et al.* 2021; Harper *et al.* 2023; Chapter 19, this work, Vol. II).

Trypillia settlement plans are mainly constituted by specific arrangements of their *elements* as the smallest constituents. Elements are defined here as single archaeological objects, for example residential houses, associated pits, public buildings, production facilities, ditches and other categories of archaeological features that can be identified in the plans. These elements then form, in different ways, *components* of the settlement plans: on the one hand, for example, individual houses are arranged in small house groups (clusters) or longer house rows. These 'active' components enclose different spaces within the settlement by forming for example streets, squares (plazas) or quarters.

The main analytical methods that were used to analyse site plans are visual observations, diachronic and interregional comparisons, quantification and measurements. The plans were divided into components and each plan has been described and analysed in two ways: individually and with regard to the spatial integration of their components. First, we discuss a particular component separately and afterwards its interplay or combination with other components and the site's development.

In addition, an attempt was made to distinguish *primary* and *secondary* components in the plans. Primary components are understood to be arrangements of elements which represent part of the original planning concept of a settlement layout. In contrast, secondary components designate parts of settlement plans that might have been developed out of an (initially unintended) dynamic only subsequently.

Criteria for this distinction are, for example, the size of dwellings related to these components, the regularity of their appearance and the specific interplay of the different settlement components. According to historical, prehistoric and ethnographic analogies, the gradation of house sizes within a settlement can be

1	Elements	Houses pits mega-structures ditches other (pottery kilns, pathways, quadrat anomalies, *etc.*)
2	Built units' components (grouping of elements)	house groups quarters + backyards house rows (concentric and radial)
3	Components of created spaces (surrounded by elements)	ring-corridor squares/plazas (main secondary) streets (radial and concentric)
4	Settlement zones	ring-corridor zone inner site zone outer site zone

Table 2. Four-level hierarchy of structural units for the analysis of the Trypillia-Cucuteni settlement plans.

used to differentiate between particularly important and less important areas, in the sense of a social topography. Consequently, the spatial distribution of house sizes can provide additional arguments for the importance of public spaces in the structure of a settlement.

Results

For a comparative description and analysis, a four-level hierarchical division of site plans was performed. This included 1) elements, 2) built units' components (grouping of elements), 3) components of created spaces and 4) settlement zones. With the help of this division of the settlement we were able to systematise and trace general trends in the Trypillia site layout developments over time (Tab. 2).

Before we proceed with the analysis of these four levels, let us briefly consider the temporal and regional variability of the *settlement size* as a proxy for local population sizes, since this aspect is fundamental for the understanding of the settlement development.

General trends of settlement development

Without being representative in the strict sense, the sample of settlements examined in this contribution reflects some general trends in settlement development and underlying demographic trends (Tab. 1; Fig. 2). On the one hand we can see the increasing concentration of population in continually larger settlements, culminating in the periods Trypillia B2 and C1 between about 4100 and 3650 BCE, after which the settlement sizes decrease strongly until about 3500 BCE. The regional distribution of settlement sizes, on the other hand, shows that the agglomeration process mentioned above led to extremely large settlements in a range between 50 and 320 ha, especially in the Southern Bug-Dnieper interfluve (Region A). In the region between Southern Bug and Dniester (Region B), however, only isolated settlements of this size occur. To the west of the Dniester (Region C), the size of the settlements does not exceed 30 ha at any time and remains in particular to the west of the Prut usually under 10 ha.

The development of settlement patterns analysed in this article is integrated into a temporally and regionally differentiated process of population agglomeration, which took place roughly between about 4200/4100 and 3650 BCE. The scale of this population concentration varied considerably from region to region insofar as mega-sites were concentrated mainly in the region around Uman between Bug and Dnieper. West of the Southern Bug such settlements were already rare, and completely absent west of the Dniester River. However, even large settlements west of the Dniester, undoubtedly represented considerable population concentrations, as can be impressively shown by the example of Stolniceni with a size of more than 30 ha and about 369 houses (Țerna *et al.* 2019).

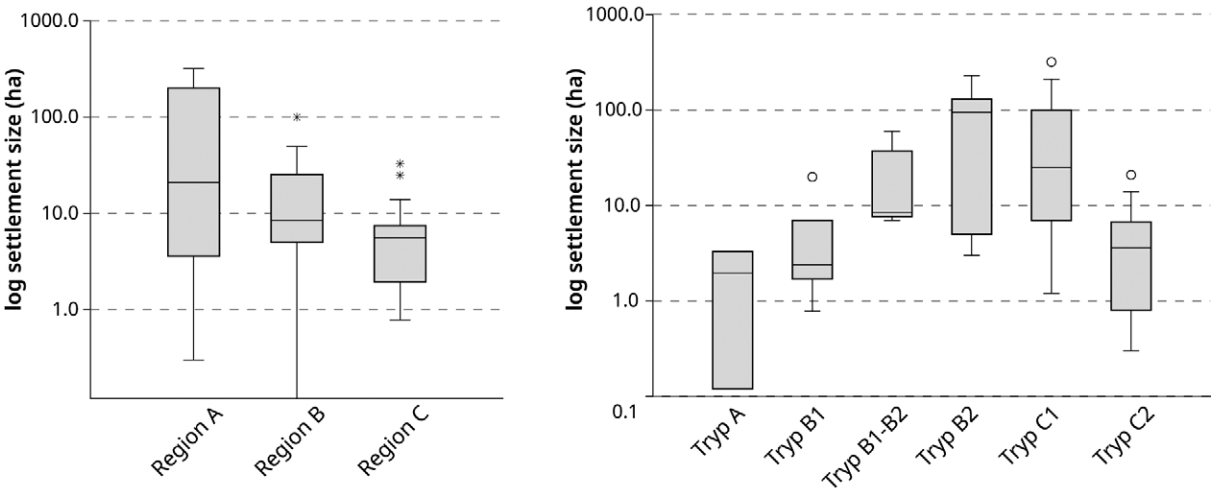


Figure 2. Settlement size of the investigated sample in regional comparison and chronological development.

Level 1: Elements of Trypillia settlement plans

Trypillian settlements, like any other villages, consist of a number of elements, by which we understand the most basic objects of anthropogenic nature, such as residential buildings. Along with houses, the magnetic maps showed public buildings, pits, ditches, pathways and other elements. Let us consider some of these.

Domestic houses and pits

Houses and associated pits represent the predominant mass of elements from which Trypillia settlement plans are constituted. So-called *ploshchadkas* represent the very specific and already often described remains of classical Trypillia houses (*e.g.* Chabanyuk 2008; Kruts 2012; Chernovol 2012; Korvin-Piotrovskiy *et al.* 2012). Trypillia *ploshchadkas* consist of packages of burnt clay, which itself are the remains of various kinds of constructions, such as clay floors (sometimes raised from the ground level), walls, sometimes ceilings, ovens, clay installations and others. Usually, these clay constructions of houses are accompanied by numerous finds.

Within Trypillia mega-sites, enormous differences in the size of dwellings between 7 and 250 m² have been observed (*e.g.* Ohlrau 2015; Rassmann *et al.* 2016a; Hofmann *et al.* 2024), the social (or alternatively economic) significance of which has so far only partly systematically explored (cf. Chapter 16, this work, Vol. II). Also, in diachronic comparison certain tendencies can be observed, for example a slight reduction of house size at the beginning of the sequence of large settlements and a strong increase in the floor size at the end of agglomerated settlements (Fig. 3). In addition, during the period of agglomerated settlements, small settlements tend to have larger houses.

In many cases, Trypillia houses are directly associated with pits, which were probably primarily used for the extraction of building material and secondarily in the context of waste disposal and ritual activities resulting in partly complex pit biographies (Müller *et al.* 2017).

The in-depth analysis of archaeomagnetic plans has shown recently that pits were often located on the opposite side from small anterooms of houses which probably marked their front side (Pickartz *et al.* 2019). We can therefore assume that pits were mostly placed at the back side of the houses. These observations regarding the location of pits probably allow us to distinguish more public areas in front of domestic dwellings from potentially more private back areas. However, in view of the longer-term occupation of Trypillia settlements, we must take into account a dynamic in which older pits were already backfilled.

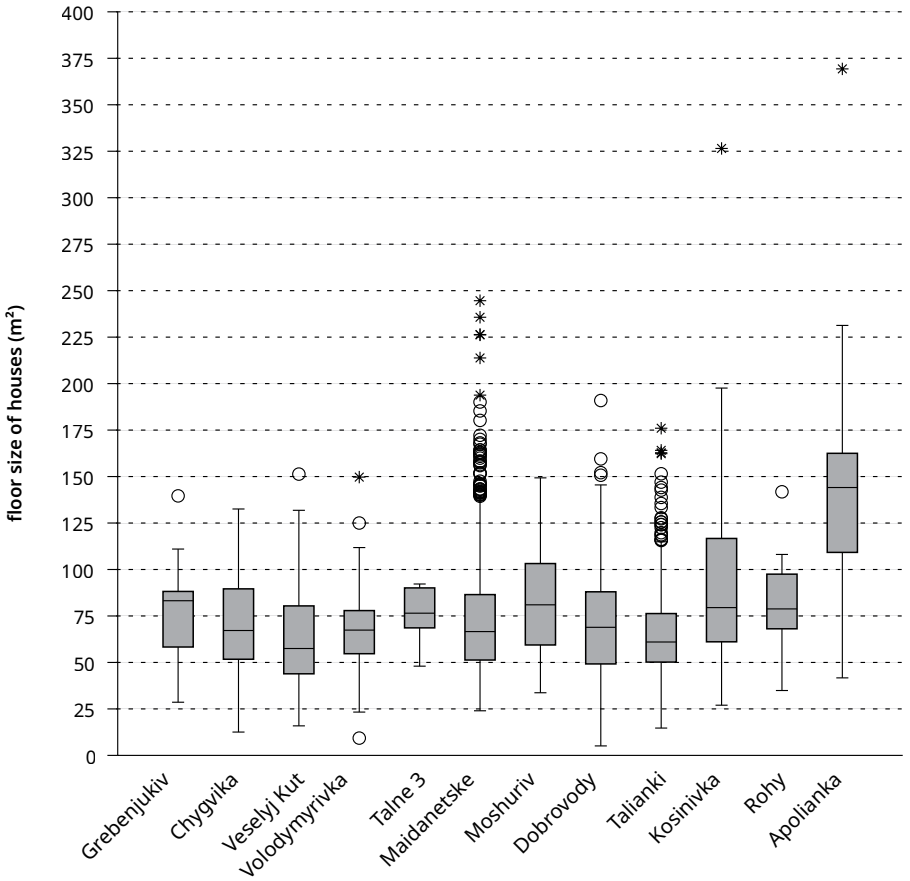


Figure 3. House floor sizes in selected settlements of the Southern Bug-Dnieper interfluve sorted in chronological order from Trypillia A to Trypillia C2.

Mega-structures

In recent times, so-called mega-structures have been systematically investigated in a separate study with regard to their chronological and regional variability (Hofmann *et al.* 2019b; Ohlrau and Rud 2019). These building structures are a special category which can be identified based on combination of three criteria: 1) highly visible positioning in public spaces in Trypillian settlement plans, 2) specific ground level architecture in comparison to domestic dwellings, and 3) their often extraordinary dimensions.

These buildings are most likely to have had primarily integrative functions within joint decision-making processes, ritual activities and the consumption of surplus. For social-historical interpretation of the settlement plans, they are of enormous importance insofar as they allow the identification and quantification of 'districts' as possible equivalents of the social organisation within the mega-sites.

Differences can be traced between the buildings of this type in different regions. For example, in Trypillian settlements of the Southern Bug-Dnieper interfluve, different integrative levels are detectable that either concerned different sub-groups of the society or the village community as a whole. The different integrative levels find their equivalents in different locations of mega-structures within the settlement: integrative buildings for the entire village were arranged in a separate square, the so-called main plaza, which was usually located in the north, northeast or east of the settlement (Ohlrau 2020; Ohlrau and Rud 2019). Integrative institutions at lower levels are represented by buildings in the ring-corridor, in radial axes, or on the periphery of the settlements (Hofmann *et al.* 2019b).

The uniform distribution of low- and medium-level mega-structures over the entire area of mega-sites is interpreted as a result of the history of the settlement

and the merger of different communities into much larger mega-sites. Probably as a response to scalar stress we observe at the end of the sequence of mega-sites a growing centralisation and the disappearance of the middle integrative level, manifested among other ways by the absence of corresponding low-level mega-structures, and the increase in size, architectural differentiation and monumentalisation of the central mega-structures (*e.g.* Viitivka, Bilyi, Kamin, Hlybochok; cf. Rud *et al.* 2019a).

Clay extraction pits for pottery production

In addition to pits that belonged to residential houses or mega-structures, in some settlements there were also considerably larger pits. One such pit with a diameter of 19 m was excavated in Talianki. Its location close to several pottery kilns indicates a function of these pits for the extraction of clay for pottery production (Kruts *et al.* 2005, 17–23; Korvin-Piotrovskiy and Ovchinnikov 2020).

Ditches

Of the 53 settlements investigated in this paper, about half (n=23) had some kind of ditches, interpreted as fortification (Przybyła *et al.* 2017) or perimeter boundaries (markers of enclosed space; *e.g.* Chapman *et al.* 2016). This spectrum of categories was recently extended by the discovery of a causeway enclosure at Maidanetske, which potentially served ritual purposes (Ohlrau 2020). Accordingly, targeted excavations are necessary to determine the precise nature of the enclosures.

If we look at the 'fortification' aspect, 11 of 23 occurrences with ditches represent settlements on naturally protected promontories, secured by section trenches at the interface to the hinterland (*e.g.* Mischka *et al.* 2019). However, as the case of Adâncata in the Bucovina shows, these trenches do not necessarily date to the Copper Age, but may also belong to other phases of use (Hofmann *et al.* 2016a). Thus, we cannot exclude the possibility of naturally protected settlements without additional fortification.

In addition to the type of settlement described as being on naturally protected promontories, round, oval or irregularly shaped ditch systems also occur on flat or slightly sloping terrain, where they partially or completely enclose settlements. Prominent examples are the aforementioned causeway enclosure of Maidanetske (Ohlrau 2020), the simple (also interrupted) enclosure in Nebelivka (Burdo and Videiko 2016; Chapman *et al.* 2016; Videiko and Chapman 2020) or the settlement of Stolniceni in Moldova surrounded by at least three ditches (Țerna *et al.* 2016; Țerna *et al.* 2019). Rectangular enclosures with rounded corners like the examples from Scânteia and Războieni-*Dealul Mare/Dealul Boghiu B* seem to represent a regional variant of the Cucuteni Region in the period around 4200 BCE.

Other elements

In addition to residential buildings, pits, mega-structures and ditches, a number of other elements could be found on Trypillia plans, but they are not typical for all sites. These are pottery kilns, 'ashplaces', small probably non-domestic buildings, *etc.* In addition, anomalies from the Trypillia time pathways are quite clearly distinguished on some sites. Since these elements are not found regularly, and do not particularly affect the basic layout of the sites under study, they are not considered in detail in this work. Here are a few examples of such elements.

In large Trypillian settlements, **pottery kilns** of an advanced type with two chambers arranged one above the other frequently appear, which can also be identified in archaeomagnetic settlement plans on the basis of their specific highly magnetic signature (Kruts *et al.* 2013; Korvin-Piotrovskiy *et al.* 2016; Țerna *et al.* 2017). This makes it possible to locate the production sites within the settlements

and to investigate the conditions of ceramics production more thoroughly (cf. Rud *et al.* 2019b; Ţerna *et al.* 2019).

In a few settlements of the Prut-Dniester interfluve, modern aerial photographs show whitish spots that are distributed radially around the settlement at regular intervals directly outside (*extra muros*) the enclosure system. These areas are also visible in magnetic plans as small-scale disturbances with positive and negative magnetised anomalies. East of the Dniester, corresponding structures have not been found so far.

In terms of their appearance in satellite images, these spots resemble so-called **'ash mounds'** from the Bronze Age, which on closer examination have been proved to be repeatedly used camps or settlements of livestock breeders and deposits of animal excrement (Sava and Kaiser 2011). The excavation of such a Copper Age structure in the settlement of Stolniceni, Republic of Moldova showed that this anomaly consists of an agglomeration of pottery, animal bones, small pits and numerous clay miniatures, strongly enriched with organic material (Ţerna *et al.* 2019). According to our preliminary interpretation, these structures represent some kind of waste heaps that accumulated on different occasions over longer periods of time.

Level 2: Grouping of elements

Individual (single) elements that can be identified on the plans of Trypillian sites often form different groups. In particular this concerns residential buildings. Let us consider some of such groups.

House groups

In large Trypillian settlements certain groups of houses (house clusters) have been identified within rows of houses, which are discussed as possible expressions of the lowest level of social organisation (kinship groups, neighbourhoods, polygamy; see Ohlrau 2015; Korvin-Piotrovskiy 2015; Rassmann *et al.* 2016a). The number of buildings belonging to such house clusters varies in Maidanetske between 2 and 41 (mean 7; median 5); in Talianki between 2 and 30 houses (mean 4.5; median 3).

Quarters

In some settlement plans, such as Stolniceni 1 and Petreni, radial and concentric rows of houses bounding the ring-corridor enclose certain settlement areas outside the ring-corridor on three sides. In contrast to the surrounding pathways, pits are concentrated in these enclosed areas. Because of this layout, this gives the impression of a quarter-like settlement organisation. In contrast to the potentially very public character of the surrounding pathways, these backyard-like internal spaces may have had a more private character. The question of the extent to which these structures also reflect a social organisation (below the level of the whole settlement) is currently under discussion (cf. Chapter 16, this work, Vol. II).

Concentric and radial house rows and 'single standing houses of similar orientation'

In many plans, some house groups are seen to form parts of a longer line or rows of houses. The length, shape and arrangement of these lines depended to a large extent on the size and the layout of the respective settlement. According to their orientation in relation to the settlement centre, *concentric* and *radial* house lines can be distinguished.

In some cases, it is not clear whether and to what extent a linear arrangement of the houses was actually intended, or perhaps one should instead consider these as single standing houses of similar orientation (*e.g.* Habşeşti-Holm). In such cases, houses are at relatively large distances from each other, are shifted in their longitudinal axis and stand rotated (not parallel) to each other. However, it should be noted that the difference between house lines and 'single houses' is extremely fluid and in many cases cannot be defined with certainty. In addition, even when we are dealing with clear rows of houses, no clear building lines are existent. On the contrary, significant 'jumps' within the building lines are the rule rather than the exception.

Level 3: Created spaces

On the third level we consider 'spaces' within the settlement that have been created by elements and groupings of elements. It is very likely that these components represent the result of settlement planning at different decision-making levels. Being practically free from buildings, these spaces represent some form of streets, corridors, squares and simply unbuilt areas. Let us consider the development of these 'created spaces' in time and space.

Ring-corridors

Classical Trypillian settlement layouts consist of concentric and radial rows of houses, the proportions of which vary considerably according to region and period. With great regularity, two concentric house rings occur, which bordered a so-called *ring-corridors* or *ring-street*. Frequently, these unbuilt zones encircled settlements completely in round, oval or irregular oval form and were usually bordered by dense rows of houses.

Beside the regularity of their occurrence, different arguments can be made for the great importance of ring-corridors for communication and transport within the settlements. This was impressively demonstrated in the examples from Maidanetske and Talianki (Kruts *et al.* 2013; Ohlrau 2015). It can be seen that the space within the sometimes very wide ring-corridors is characterised by a high degree of public visibility.

In the newly obtained high resolution magnetic plans, different categories of special buildings have been identified within the ring-corridors, which provide clear indications for their public character, such as exceptionally large sizes, single-storey partly unroofed architecture and highly visible and isolated and sequential placement (Hofmann *et al.* 2019b).

Curved rows of houses occur already in fortified settlements of the Cucuteni type from the second half of the 5th and the beginning of the 4th millennium BCE, such as Putineşti 3, Ghelăieşti-*Dealul Nedeea*, Sîngerei-*La Cazasu* and Trostianchyk, each located on the interface with the hinterland. These curved house rows have been taken into consideration as precursors of ring-corridors, although it is not clear in the most cases if they actually followed trackways or only semi-circular fortification ditches (Țerna *et al.* 2018). Therefore, in our view, the identification of these curved rows of houses as forerunners of the classic Trypillia layout is speculative.

Up to now, the Trypillia A site Bernashivka 1 was considered as one of the earliest examples of a centripetal settlement layout with a central unbuilt space and a central building (Zbenovič 1996). However, recent excavations of Chernovol (2016) showed that the earlier excavated dwellings belonged to a settlement with similar aligned houses. Comparable settlement layouts were also observed in other Trypillia A sites such as Grebenyukiv Yar.

According to the available data, ring-corridors occurred in the periods Trypillia B1 or B1–B2. The earliest cases in our dataset from Vilshanka, Zabolotne, Ternivka

near Kryzhopil (Region B), and Chyzhivka, Veselyj Kut near Uman (Region A) date to the period between 4,200 and 3,950 BCE (Chapter 14, this work, Vol. II).

Settlement plans from Region B are characterised by more or less round or slightly oval shapes. In contrast, in Region A, early sites of this type have a cloverleaf-shaped ring-corridor. These East-Trypillia settlements (Chyzhivka and Veselyj Kut) seem to follow the natural topography. Alternatively, the repeated widening and narrowing of the ring-corridor could be a relic of the (incomplete) merging of several smaller groups into a much larger community in the context of the formation of an early mega-site (Chapter 11, this work, Vol. I).

In the region between the Prut River and the Dniester-Southern Bug watershed, the round or only slight oval configuration of ring-corridors was maintained in the periods Trypillia B2 and C1. This can be demonstrated for example in Stolniceni 1, Petreni and Trinca.

During this time period, in the Southern Bug-Dnieper region the layout of giant settlements (Volodymyrivka, Nebelivka, Hlybochok, Maidanetske and Talianki) is apparently determined to varying degrees by the site topographies. Although the ring-corridors of some of these settlements (*e.g.* Nebelivka) show already a much more parallel course, here too there is some small widening which relates to special buildings arranged in regular intervals within the ring-corridors. As will be shown in the next section, these special buildings provide a key to understanding the social organisation within Trypillia mega-sites and the settlement plans.

In order to gain a better understanding of the extent to which ring-corridors are the result of planning, it is necessary to examine their dimensions. Let us have a closer look at the width and length of ring-corridors at the key sites. The median width of ring-corridors was measured repeatedly at as many locations within the settlement as possible. The lengths of the ring-corridor are mean values of measurements along the inner and outer house rows.

Widths of ring-corridors range between 30 and 150 m, thus they usually vary considerably within a settlement and over time (Fig. 4a, b). While a relatively clear correlation seems to exist between settlement size and the width of the ring-corridors in Regions B and C, in many of the Bug Dnieper interfluve settlements (Region A), the ring widths do not continue to increase proportionally with the settlement size, above a certain threshold.

Correspondingly, ring-corridors at Volodymyrivka (77.5 m), Nebelivka (80.5 m), Maidanetske (87 and 89 m) and Talianki (87 m) show relatively similar median widths. Ring-corridors of larger size were detetected at Dobrovody (150 m) Hlybochok (109 m), and Kosenovka (127 m). While in the cases of Hlybochok and Kosenovka these values could be explained with reference to the relatively small size of the surveyed areas, Dobrovody might represent a 'real' ring-corridor with a large width. This is indicated by, for example, one of the largest known low-level mega-structures of all, which is located in this corridor.

In contrast to the variable relation of ring width and settlement size, there is a clear correlation between the length of ring-corridors and settlement size (Fig. 4c). This is surprising since the intensity and extension of overbuilt areas outside the ring-corridors varies greatly.

All remaining structural components are oriented to the ring-corridors, which proved to be a very consistently occurring basic structural element of Trypillia settlements. Concentric ring-corridors did not appear before the last centuries of the 5th millennium BCE in Trypillia contexts. Deviations from an ideal round or oval course and regularly occurring widenings indicate that the ring-corridors of mega-settlements are likely to be the result of the fusion of different communities, thus providing the built manifestation of the integrative concept of these settlements. The relatively high degree of correlation between the length of the ring-corridor and the settlement size, but also the similar maximum widths of several ring-corridors, are clear indicators that their configuration was based on careful planning.

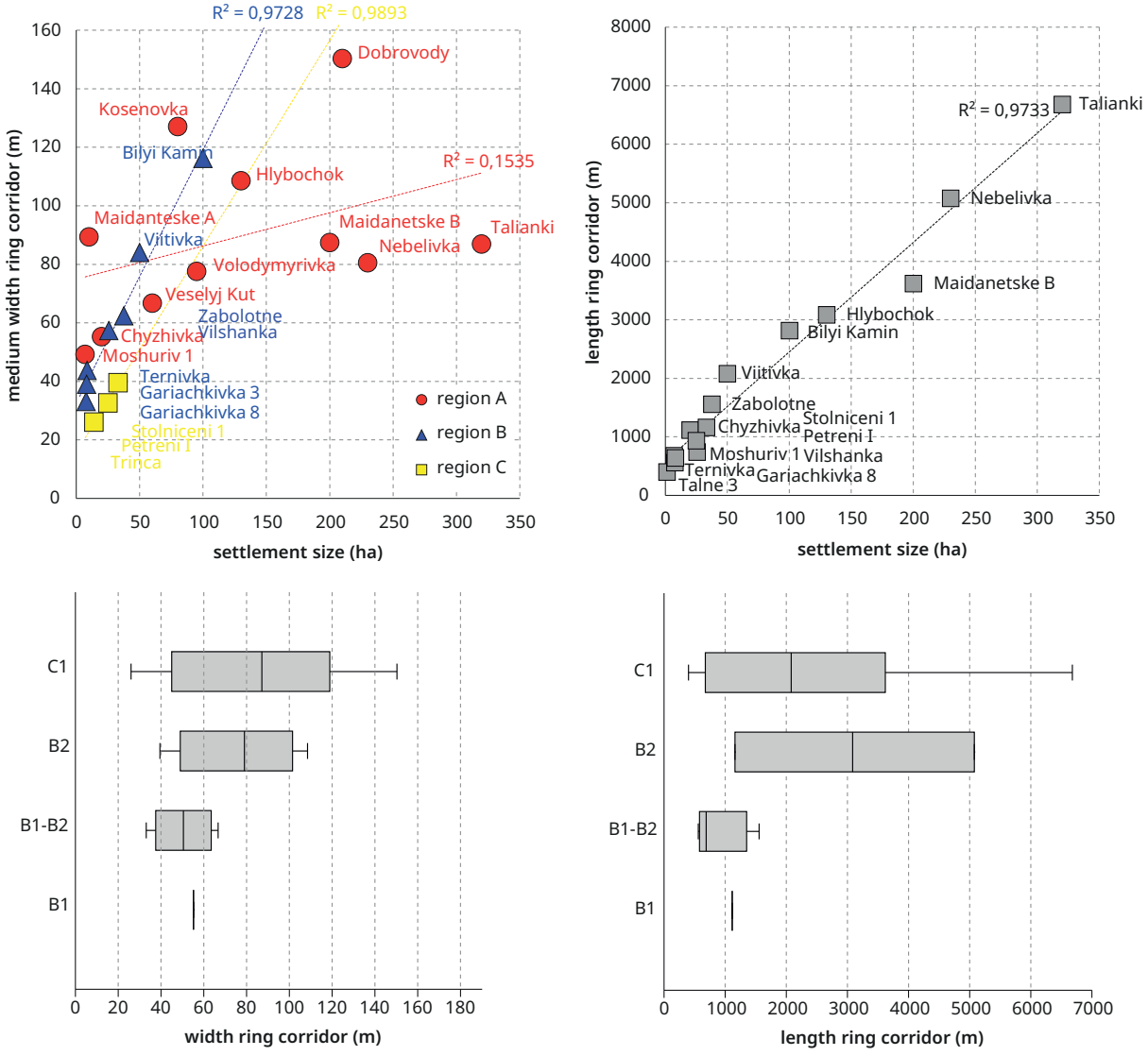


Figure 4. Dimensions of ring-corridors in Trypillia settlements. A) widths of ring-corridors in relation to settlement sizes for the three study regions A–C; B) Widths of ring-corridors in different Trypillia phases. C) lengths of ring-corridors in relation to settlement sizes. D) Lengths of ring-corridors in different Trypillia phases.

Concentric streets

Apart from the house rows that border the ring-corridor, longer and densely built house rings occur mainly in large settlements such as Maidanetske, Dobrovody, Talianki and Kosenovka. The linear areas (streets?) between these house rings seem to have been of secondary importance, as there was no obvious attempt to create areas free of pits in between them (Fig. 5a).

Shorter concentric roads appear for the first time in the periods Trypillia B1–B2, *e.g.* in the area east of the Dniester, *e.g.* in Chyzhivka, Veselyj Kut and Hariachkivka 8. However, in these early examples, the houses are standing in some cases relatively far from each other (Chyzhivka) or have instead the character of house groups (Hariachkivka 8). This also applies to Trypillia B2 period settlements such as Bilyi Kamin, Nebelivka and Volodymyrivka.

In settlements west of the Dniester, concentric house rings are generally much rarer and occur almost exclusively as boundaries of the ring-corridor. In contrast, the built space of settlements outside the ring-corridor zone is largely characterised by radial rows of houses. A possible exception from this trend is the Trypillia C1 settlement Trinca near Edineţ in the Republic of Moldova.

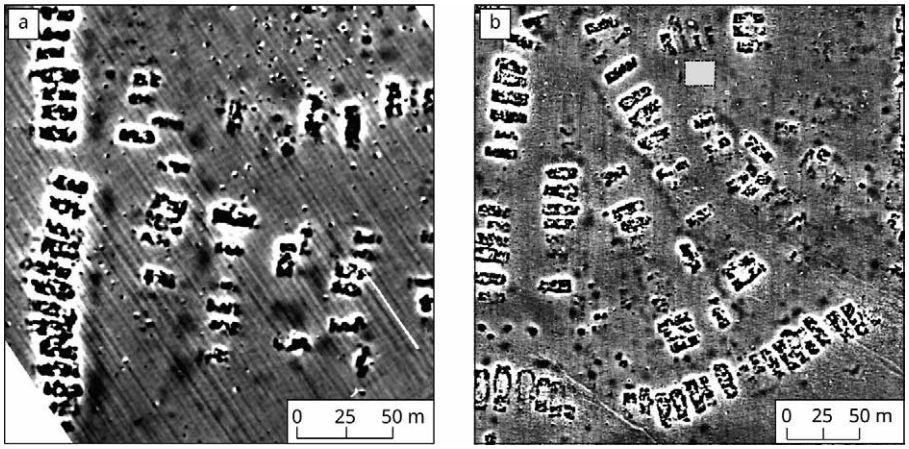


Figure 5. Details from magnetic plans which show the relation between A) concentric (Dobrovody) and B) radial (Volodymyrivka) house rows and associated pits.

Radial streets

Radial streets constitute access axes that run perpendicular to the concentric house rings and pathways. Uninterrupted radial streets, running from the centre to the outer edge of settlements can be distinguished from those which led from the ring-corridor inwards or outwards. There is a further distinction in the way radial streets are indicated in the settlement plans. Some are marked by gaps within concentric house rings, whereas others are aligned by radial house rows. Within the last category, a distinction can be made between radial streets with single house rows and those with double house rows. Additionally, in a couple of cases linear anomalies of pathways exist, which run between houses from the settlement outskirts radially inwards (*e.g.* Țerna *et al.* 2019).

It seems very questionable if all radial house rows actually represent streets and to what extent gradations exist with regard to their importance (streets, pathways *etc.*). Important clues regarding this question can be derived from the location of pits associated with the houses. A network of equal pathways running in radial directions is indicated in Volodymyrivka, for example, by rows of pits which are in each case situated at the same side of the houses (Fig. 5b). In contrast, there are radial rows of houses in Stolniceni 1, where pits mark some kind of backyard areas. In between these backyard areas, corridors exist which are free of pits and partly show linear anomalies of pathways.

In an interregional comparison clear differences become evident between the study regions B and C west of the Southern Bug River, on the one hand, and the Southern Bug-Dnieper interfluve (region A), on the other hand: radial house rows are much more frequent in ring-shaped settlements west of the Southern Bug, than to the east of it. These rows frequently run from the periphery of the settlements to the ring-corridor, starting in periods Trypillia B1–B2 (4200–4000 BCE). Beyond the ring-corridor, these radial paths do not run further towards the centre of the settlement.

In the region east of the Southern Bug, we detect radial streets only in plans from after 4,000 BCE. In contrast, in the western part of the working area, radial roads run much more frequently through from the periphery to the centre of the settlement on both sides of the ring-corridor. In mega-sites such as Nebelivka, Maidanetske and Talianki, these radial axes are often related to mega-structures located within the ring-corridor or on the edge of the settlement.

Consequently, radial streets represent components of Trypillia plans that are manifested in diverse ways and closely linked to the concept of concentric house rings. There are remarkably pronounced regional patterns which show a division of the working area into two parts. This division was maintained over a long period of time from about 4200/4100 until at least 3800 BCE.

Primary plazas

Settlement plans with a rectangular plaza encircled by houses and oversized buildings already appear regularly in settlements of the Cucuteni type on naturally fortified promontories such as Adâncata A, Ghelăieşti, Habasesti, Putinești 3, Ripiceni, Truşeşti, and Trostianchyk. These plazas are usually located at the most accessible point of the settlement at the interface of the promontory and the hinterland. This often allowed, when accessing a settlement, a direct view of the central mega-structure, which was placed at the end of the plaza.

For concentric Trypillia settlement plans of Trypillia Phases B2–C1, René Ohlrau and Vitalii Rud drew attention to the regular occurrence of central mega-structures and an associated plaza in the north, east or northeast of the settlement plans (Ohlrau and Rud 2019).

In the early East Trypillian settlements Chyzhivka and Veselyj Kut, situated in the region east of the Southern Bug (A), we are dealing with a completely different situation. Here, central mega-structures are placed at triangular widenings of the ring-corridor.

In Volodymyrivka, Nebelivka and later on also in Maidanetske, for the first time rectangular plazas surrounded by houses occur east of the Dniester River (regions A and B). In each of these cases, there is only a single mega-structure which is still in alignment with the houses of the ring-corridor. Mega-structures which were spatially separated from this building line we find for the first time in Hlybochok and later on also in Viitivka and Bilyi Kamin west of the Southern Bug River. In the latter cases, there are not only one but several buildings in the mega-structure position standing next to each other.

With regard to the placement of mega-structures in relation to the plaza, regional differences were maintained over a longer period of time: while east of the Dniester mega-structures became separated from the ring-corridor, at Petreni and possibly also at Stolniceni central mega-structures were placed at the end of the plaza according to the ‘Cucuteni-pattern’.

Consequently, different developments are observed with regard to the central plaza: 1) increasing separation of the mega-structures from the inner row of the ring-corridor, 2) the increasing establishment of a rectangular plaza surrounded by houses, and 3) increasing numbers of mega-structures at this place. However, there are indicators that neighbouring mega-structures were not built at the same time but one after the other. As has already been shown elsewhere, from an architectural point of view, this process goes hand in hand with the increasing enlargement of the buildings and the structural differentiation in comparison to normal residential buildings (Hofmann *et al.* 2019b).

Secondary plazas

In some settlements, small plazas exist in addition to the primary (main) plazas at other locations within the settlements. In contrast to the main plaza, the mega-structures standing on these much smaller squares belong to a category of integrative architecture for only a part of the local population.

Such squares with small mega-structures are most obvious in Maidanetske, where they are placed at the end of radial streets in the zone enclosed by the ring-corridor (Fig. 6). They are referred to as ‘secondary’ because they are located in an area of the settlement that was probably only successively overbuilt during the lifetime of the settlement.

The earliest possible evidence for a secondary plaza in our sample is in Volodymyrivka: Here, a small mega-structure was located at the intersection of different radial axes in the zone within the ring-corridor. Self-evidently, secondary plazas only occur in settlements with low-level mega-structures. Therefore, they are completely missing west of the Southern Bug at least according to present knowledge.

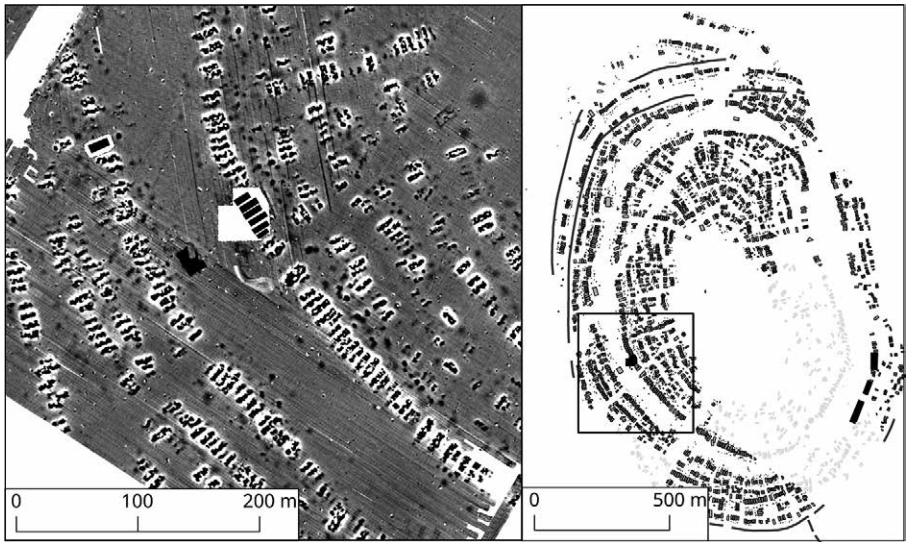


Figure 6. Detail from the magnetic plan in Maidanetske showing a radial street and at the inner end a secondary plaza with a small mega-structure (magnetic plan: K. Rassmann; redrawing of the magnetic plan: R. Ohlrau).

Unbuilt central areas

One of the components of the settlement plans formed of houses and pits is an unbuilt central area in large sites. It was probably the prominence of these places in settlement plans that encouraged some researchers to adopt far-reaching interpretations. For example, a development from the centre to the outside of the sites was proposed, in connection with the attempt to establish intra-site chronologies for the mega-sites Maidanetske and Talianki (Shmagliy 1980; Ryzhov 1990, 83–90; Shmagliy and Videiko 1990, 92–93). Following this logic, the settlement layout was called '*centripetal*', implying a particular importance of this central free space for the functioning of the sites.

However, how can we prove the assumption that the central area was important in Trypillian times? What is the evidence for this conclusion? What can our data testify? The situation becomes more complicated because there is no clear definition of what '*central unbuilt space*' actually means and according to which criteria it can be defined. Thus, as a starting point we would like to propose the understanding of a space as an 'unbuilt central area' only if it is wider or equal to the mean width of the ring-corridor. This criterion may seem arbitrarily chosen, however, as was shown above, ring-corridors seem to represent a crucial element of the plans, whose width is related to the settlement size and might, thus, provide a good reference point also for the central part of the site.

When applying this criterion, out of the 23 sites in our sample with an oval layout, a minimum of 12 settlements displays this free undeveloped space. No site that shows such a feature is smaller than 25 ha. Rather, it seems, with some exceptions (Zabolotne, Volodymyrivka?) such unbuilt central areas occur regularly in settlements over 25 ha in size.

Although there is undoubtedly a certain correlation between the size of a settlement and the size of the undeveloped area in the settlement centre, we can observe partly pronounced deviations from a linear regression (Fig. 7). While sites like Veselyj Kut and Talianki show particularly large undeveloped areas, the size of such areas in Maidanetske and Hlybochok is below the average. In the case of Maidanetske, the below-average size of the central area could be explained by an above-average number of buildings in the zone within the ring-corridor. In contrast, in the case of Hlybochok, the below-average size of the undeveloped area appears to be based more on other factors.

A regional comparison reveals a clear picture that central undeveloped areas are concentrated in the Bug-Dnieper interfluve, where also the largest settlements

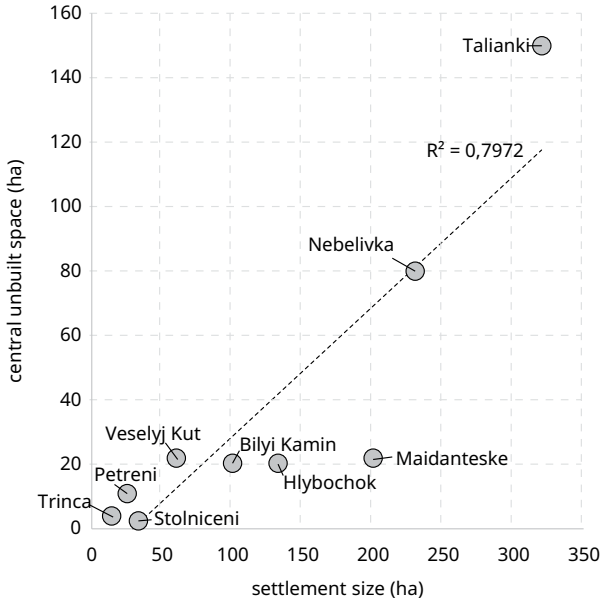


Figure 7. Relation of settlement size to size of the unbuilt central area of large Trypillia sites.

occur. A certain chronological trend towards 'over-large' undeveloped areas seems to correspond with the general increase in the size of large settlements.

Different indicators contradict the assumption of a particularly important role of unbuilt areas for public interactions in large Trypillia settlements:

- Backyard areas of the houses are oriented towards this unbuilt space.
- In contrast to other public squares, central unbuilt areas do not have clear borders.
- The areas show no clear shape/size patterns.
- Houses close to the central unbuilt area are smaller in size, compared to the ring-corridor. In our view, such site-internal differences in house size might reflect social differences comparable with social topography in medieval and early modern towns.
- There are no public facilities such as mega-structures situated within central unbuilt areas.
- The occurrence of central unbuilt areas is restricted to large and mega-sites.

Consequently, there are no indicators for use of these undeveloped areas as public squares. Rather, all the evidence argue against their high importance. This conclusion is also supported by the results of several test trenches in the centre of the settlement Maidanetske, which neither provided any finds nor showed particular geochemical signatures indicative of intensive human impact. Accordingly, agricultural activities were most likely to be carried out there (Chapter 5, this work, Vol. I).

Level 4: Zones

Most of the 'ring-shaped' Trypillia sites can be divided into three different zones. These are considered as specific arrangements of both kinds of components: 'grouping of elements' (Level 2) and 'created spaces' (Level 3). Zones are separated from each other by marked changes in the arrangement of components. We distinguish the following three zones: the ring-corridor zone, the inner site zone and the outer site zone.

Basic characteristics

The *ring-corridor zone* is formed by two concentric circuits of houses and the unbuilt ring-corridor in between of them. In large settlements and mega-sites, mega-structures are frequently placed at highly visible positions within this zone.

The bordering house rows of ring-corridors do normally not run parallel, as may seem at first glance, but show different widenings and contractions. As it was shown before, widenings frequently occur related to positions of mega-structures and crossing points with radial streets. This often gives the impression of representing a series of small settlement cores. This finding might indicate that the construction of mega-structures was already planned or carried out from the very beginning of the settlement.

In many settlements, the majority of the domestic dwellings are located within the two rows of houses of the ring-corridor (Fig. 8). Additionally, these house rows are often characterised by a particularly high building density and larger floor sizes than other zones.

Consequently, the ring-corridor zone is not only an extraordinarily steadily-occurring structural element of Trypillia settlements, but a settlement part that stands out in several other respects: by linkage with integrative architecture, by a large number of houses and by particularly large buildings. In addition, the ring-corridor zone often forms the interface between the differently structured inner and outer site zones.

Built space with 'streets' and 'plazas' which are encircled by the ring-corridor is considered as the *inner site zone*: this comprises the main plaza that is mostly located in the east or northeast of the settlement, regardless of the location of the settlement in the terrain. Furthermore, concentric and radial rows of houses and streets and secondary plazas with mega-structures can belong to the inner site zone.

Although in the inner site zone of some large sites extensive residential quarters with radial and concentric streets exist, the arrangement of the houses shows a much more unplanned character. This is indicated for example sometimes by very short house rows and frequent changes in their direction. Additionally, a high density of pits indicates rather private and less representative areas.

In addition, the houses in these zones tend to be smaller than those on the ring-corridors, probably reflecting social differences. All these points contribute to the impression that the zones within the ring-corridor tend to be more peripheral areas that were used for house building when other zones of the settlements were already occupied.

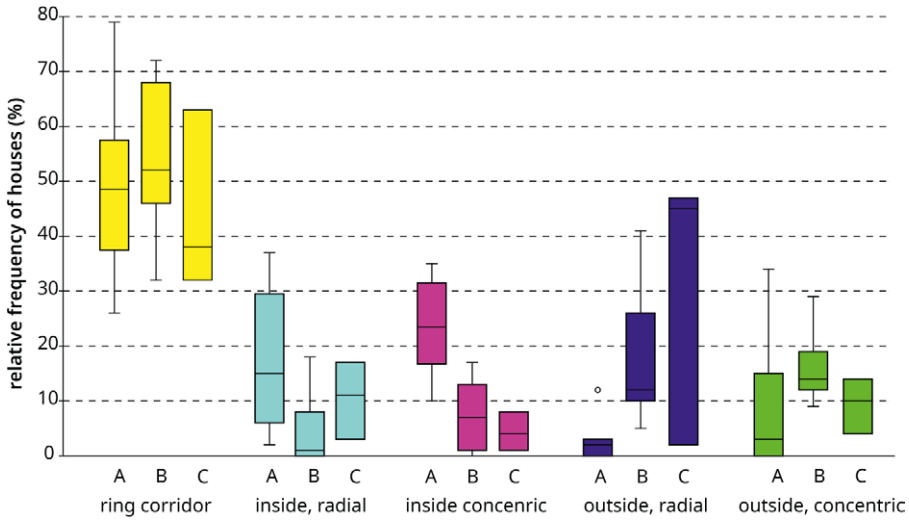


Figure 8. Comparison of relative frequencies of houses in different components and zones of Trypillia ring-shaped settlements differentiated across three study regions. (A – Maidanetske and Sinyukha Region; B – Bug-Dniester Interfluve; C – Prut-Dniester Interfluve).

The *outer site zone* of ring-shaped Trypillia settlements is characterised by a certain variability: in several sites this zone is structured by shorter or longer radial rows of houses which run to the ring-corridor and formed of only a small number of radial and concentrically arranged buildings. In contrast, the number of buildings in the outer site zone is very low in several other sites, (Volodymyrivka, Chychivka, Dobrovody, Nebelivka). In such cases of weakly developed outer site zones, ditches frequently seem to restrict the growth of the settlement. In Maidanetske, extended zones with concentric house rows are rare, while in some other sites concentric rows are mainly concentrated in the area of the central plaza (Bilyi Kamin, Hlybochok).

It should be noted that the distinguishing of three site zones is far from being the only option as to how the space of the settlements of this type could be divided. For example, researchers of the Nebelivka site proposed a division of this settlement into 14 segments. Along radial streets, the site is divided into several ring-segments. To these ring-segments in each case pairs of mega-structures (in the ring-corridor and at the outskirts of the settlement) are attached, which form together with the houses some kind of settlement cores or districts. These units are interpreted as settlement parts from populations of different origins (*e.g.* Nebbia *et al.* 2018; Gaydarska *et al.* 2019).

The division into segments demonstrates quite well the spatial distribution of different elements and the element groups in Nebelivka. However, in the majority of other site plans, a division according to a similar principle is rather difficult. For this reason, the division of three concentric zones, which depends on the ring-corridor, seems to be more appropriate to enable an inter-site comparison.

Zone differences between small and large sites

Despite the fact that our sample is not very large – 24 settlements (out of total 53) show a ring-shaped layout – we are able to trace some differences between the settlements. In addition to chronological and regional ones, structural differences can be observed between small settlements on the one hand and large and mega-sites on the other.

Of the 24 ring-shaped sites, eight are quite small (up to 10 hectares). It should be noted the ring layout was characteristic of both large and small settlements, from the oldest ones known. This trend remained the case throughout the entire existence of such sites.

From early examples, clear differences show in the development patterns of the zone encircled by the ring-corridor: while for example in Zabolotne a relatively large and densely built area is encircled, the much smaller space in Vilshanka is almost unbuilt. At the same time, in the Bug-Dnieper interfluve, Veselyj Kut buildings are restricted to the ring-zone, and in Chizhovka the space within the outer ring is quite densely built up.

At later times (B2–C1), the small sites in Region A demonstrate the existence of only a 'ring-zone' (Moshuriv 1) or the presence of only one building ring, and, consequently, the absence of a zonal pattern (Talnoe 3). At this time, the large settlements of this region demonstrate a strikingly clear division into zones.

At the Moldovan sites Sofia A and B (Trypillia B2–C1), although they do not have detailed magnetic plans, ring-zones are clearly developed. There, almost no anomalies occur outside these rings. It is possible that few buildings were present in the centre of the sites. Large sites from the same period and area display strongly contrasting layouts. For example, Stolniceni 1 and Petreni have a pronounced developed external zone.

Thus, in general, small sites differ significantly from large sites. Although small settlements belong to different time intervals, they have some common structural similarities. In almost all cases (except for Talnoe 3), the presence of two building rings can be observed and, accordingly, the circular zone. Many of these sites have mega-structures (except for Talnoe 3). In addition, some buildings outside this zone

can be traced. However, in most cases these dwellings do not form 'site zones', but instead represent singular house, or groups of houses that lie in different directions with respect to the circular corridor (radial, concentric). Only the plan from Garyachkovka 8 demonstrates more or less clearly a structured outer zone.

Let us move on to the differences between the zones of settlements in different regions.

Regional differences

As was already demonstrated before to some extent, there are some very clear regional (and probably chronological) differences within site zones. These differences mainly concern the outer and to a lower extent the inner site zones. The characteristic component in all regions is the ring-corridor.

Differences with regard to the inner site zone concern mainly the building density and the different proportions of radial and concentric rows of houses and streets. The type and intensity of the built space is to a great extent determined by the space available. Thus, longer concentric or radial rows of houses mainly occur in large sites of the Southern Bug-Dnieper interfluve and to a lesser extent elsewhere.

The zone outside the ring-corridor in Trypillia settlements shows strong regional differences. The usual pattern in the region west of the Dniester-Southern Bug watershed is the existence of radial house rows outside the ring-corridor. These radial rows of houses, as in the case of Vilshanka, can be very long and occupy a correspondingly large area. In many other examples, measured by the total size of the settlement, these house rows are rather short (Stolniceni 1, Petreni, Zabolotne).

The question arises of whether the radial rows in the outer site zone of Western sites were the result of primary planning or secondary growth of settlements and the filling of empty space? The overall low building density in Vilshanka seems to indicate that the rows in the outside site zone were planned from the beginning. Thus, this settlement may never have been fully built.

East of the watershed of Dniester and Southern Bug, ring-corridors often mark the outer periphery of settlements (Chyzhivka, Veselyj Kut, Volodymyrivka, Dobryvody, Talianki). Exceptions concern concentrations of concentric house rows and streets near the main plaza (Hlybochok, Bilyi Kamin).

The Maidanetske settlement represents a special case insofar as one to four concentric rows of houses are arranged between a single ditch and the ring-corridor. Beyond this inner ditch, two further concentric rows of houses and an outer ditch are arranged to the north of the settlement, probably marking an extension phase of the settlement. Moreover, this exceptional situation might be partly the result of the complex site history in which the ditch – actually a series of ditch segments – represents one of the earliest elements.

In the following paragraphs, we would like to support the observations on regional specifics with some quantitative analysis. The distribution of houses in different components and zones reveals some clear regional differences (Fig. 8). In all regions, the majority of houses belongs to the ring-corridor, where the percentage ranges between 30–80% of houses. In Regions A and B the proportion is on average higher (by 50%; median) than in Region C (<40%; median).

Although Region B has a mediating position in several respects, the comparison shows clearly a differentiation between Region A, on the one hand, and Regions B and C, on the other. Settlements in the Southern Bug-Dnieper Interfluve (A) are characterised by a strong focus on the inner site zone. Correspondingly, many houses belong to concentric and radial house rows of this zone, while the proportions of the outer site zone are lower.

In contrast, in Regions B and C, generally a much smaller proportion of the houses are present in the inner site zone; instead, the development is focused on the outer

site zone and especially on radial rows of houses there. This pattern is in particular clearly visible in the settlements Petreni and Stolniceni 1 west of the Dniester (C).

The regional patterns described above are also very clearly expressed in a correspondence analysis, which includes the number of ditches and the arrangement of mega-structures as additional parameters (Fig. 9). The first axis of this analysis is dominated by a dichotomy between settlements with many radially arranged houses in the outer site zone, on the one hand, and radially and concentrically arranged houses in the inner site zone, on the other.

The distribution of settlements in the ordination diagram follows a geographical gradient from west to east. As a regional outlier, the settlement of Trinca stands out, whose layout with concentric house rings in the inner site zone and the lack of radially arranged houses in the outer site zone strongly corresponds to the pattern in Region A. Another regional trend concerns the greater frequency and number of trenches in the west of the study area. The separation of Maidanetske in the second axis of the ordination diagram is based on the unusually high number of concentrically arranged houses in the outer site zone of this site.

To sum up, the proposed division of sites with Trypillian layouts into three zones is reflected by characteristic structural differences. Of course, the main zone of this type of sites is the ring-corridor. The remaining two zones are directly dependent on this corridor. The dominance of the ring-corridor is expressed as follows:

- This is a necessary element of all plans of this type,
- The ring-corridor zone underwent almost no changes over the time of its existence (4200–3650 BCE),
- The corridor is present on both large and on small sites (where other zones may be less clearly expressed),
- Most of the houses from the sites (50% and more) were located here,
- Houses that are located here are larger than those in other zones.

For other types of sites at the territory under consideration, zoning is not characteristic. First of all, this concerns settlements of the Cucuteni type and the late, degraded Trypillia sites. Settlements structurally characterised by the three zones discussed date exclusively to the periods from B1–B2 until the end of C1 (ca. 4200–3650 BCE).

Discussion

The settlements included in this investigation reflect the general trend of increasing population agglomeration and growing settlement sizes. This trend becomes visible at the latest during the phases Trypillia B1–B2 around 4200 BCE and does not start to decrease before about 3650 BCE, accompanying the disintegration of the Trypillia giant settlements at the beginning of the period Trypillia C2.

The components of Cucuteni-Trypillia settlement plans, described in this paper, are mainly constituted by the specific arrangement of houses, burnt with different intensity, and associated pits. These houses form clusters of different size, which join to longer rows, enclose squares or ‘plazas’ and form in part some kind of quarters. Ditches and pottery kilns are other more infrequently appearing elements of Cucuteni-Trypillia settlement plans.

Basic types of Cucuteni-Trypillia settlement layouts

At least two basic types (and several sub-types) of settlement plans can be distinguished based on our description and analysis of 53 settlement: Several settlement plans are characterised by more or less uniformly orientated or perpendicularly arranged houses or groups of houses. These **‘Cucuteni-type’**

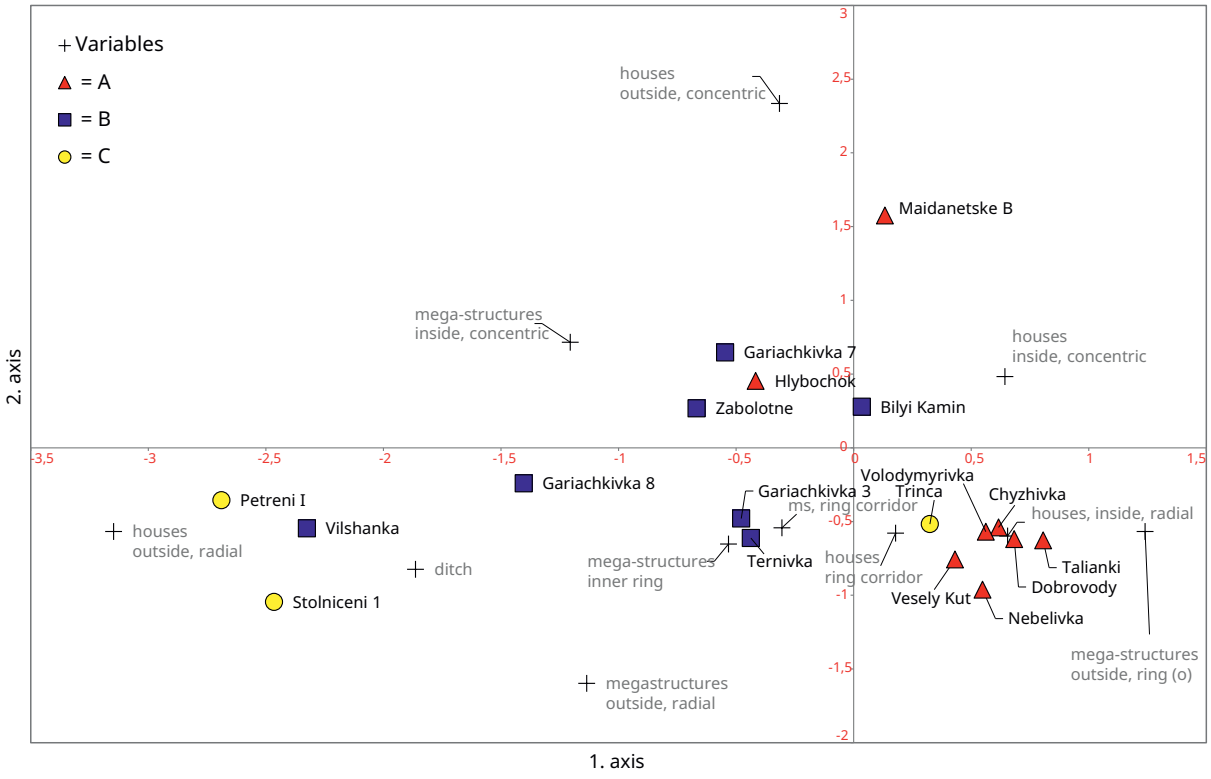


Figure 9. Ordination diagram of the first two axes of a correspondence analysis analysing the numbers of houses, ditches and mega-structures in different parts of Trypillia settlements. Circles, squares and triangles indicate the allocation of a settlement to the study regions A, B and C. The first axis explains 49.94% and the second axis 31.36% of the variability.

labelled settlements are frequently located either on top of protected promontories or in open terrain on lower river terraces.

Sub-types of the 'Cucuteni layout' already occur in the first half of the 5th millennium BCE. 'Trypillia A settlements' (Grebenyukiv Yar, Bernashivka 1) represent such a 'Cucuteni pattern' sub-type in which, as far as we know, no ditches, no clear house rows and no mega-structures have been detected so far. However, as the case of Baia at the foot of the Carpathians shows, mega-structures existed already at that time (Ursu and Țerna 2015; Hofmann *et al.* 2016b).

Later examples of the period Trypillia B1 (ca. 4500–4200 BCE) are frequently characterised either by location on naturally protected promontories (*e.g.* Fulgeriş La Trei Cireşi) or by their location within rectangular ditch systems (*e.g.* Scânteia-Delaul Bodeşti, Războieni-Dealul Mare/Dealul Boghio).

Settlements of the above-mentioned sub-type show regularly a rectangular plaza with an oversized mega-structure. They are situated in a fixed position at the entrance. In some settlements of this type proper house rows with different directions ('radial' and 'concentric') exist (*e.g.* Putinești 3, Trostianchyk). We do not see within such settlements any indication of ring-corridors or ring-corridor segments and no division into zones.

Our sample of settlements of the Cucuteni type may be biased, since it is derived mainly from early periods before 4000 BCE. However, as the late example of Gordineşti may show, such settlements could have existed until late Trypillia time (C2). Geographically, they are concentrated in the region west of the Prut River. More eastern examples occur as far east as by the Southern Bug River where, however, only a few examples are known, and which consistently date to around 4000 BCE (Trypillia B2).

Settlements labelled as **'Trypillia-type'** are mostly located in open terrain, with radially positioned houses and concentric ring-corridors. These settlement plans represent the classical layout of Trypillia settlements, which are the focus of this paper. Frequently occurring components of settlement plans of the Trypillia type are: 1) an

unbuilt 'ring-corridor' which has been left free between the concentric house rings; 2) a built, partly built or unbuilt zone in the centre of the settlement; 3) radial trackways that lead into the site crossing the concentric house rows, ring-corridor and enclosures aligned along house-empty spaces which are interpreted as communication paths; 4) concentric rings of houses around a central built or (partly) unbuilt space; and 5) enclosures that demarcate certain areas within the site and around the site.

According to our analysis, the ring-corridor and the adjoining rows of houses were the most basic components of classical Trypillia settlements, towards which, potentially, all other components were orientated. The ring-corridor was undoubtedly based on precise planning, as might be indicated for example by relatively high degrees of correlation between the length of the ring-corridor and the settlement size, but also by comparable maximum widths. There is an overwhelming number of indicators which underlines the special importance of this ring-corridor zone as a focal area of communication and interaction: 1) its omnipresence in the entire study area; 2) the high number, density and size of houses; 3) its location at the interface of differently structured inner and outer site zones; and 4) its use for the placement of integrative buildings.

The re-evaluation of the unbuilt centre of classical Trypillia settlements revealed the relatively minor importance of this area in contrast to the ring-corridor. Unbuilt inner areas occur mainly in settlements larger than 25 ha in size. In small settlements, the limited space available may have been the decisive factor in favour of overbuilding this area. In very large settlements, the unbuilt area seems to be, rather, a result of the strong enlargement of the ring-corridor and the resulting abundance of space. In principle, the whole space within the ring-corridor seems to be a spatial reserve for the growth of the settlement. Additionally this space afforded, undoubtedly, a wide range for special uses. However, to date, no specific activities have been identified in the unbuilt centre. For this reason, uses such as for keeping livestock, for gardens or as a wooded unbuilt centre are most likely.

Within settlements of the ring-shaped pattern some clear regional differences were identified which divide the working area into at least two areas (Fig. 10). The border between these two regions might be roughly the watershed between Dniester and Southern Bug, although we have several outliers from this general trend. We see on the one hand a *western Trypillia pattern* with radial house rows focused on the outer site zone. With the exception of Petreni, the usually medium sized villages of this pattern had only central mega-structures.

Around approximately 4200 BCE settlements of the *Earlier East Trypillia pattern* occur east of the Southern Bug River, characterised by cloverleaf-shaped ring-corridors and perhaps the first low-level mega-structures. Practically no radial streets existed in such settlements.

A further development is represented in the *Later East Trypillia pattern*. In the sometimes extremely large settlements of this pattern, multiple mega-structures occurred, mostly focused on the ring-corridor zone and the inner site zone. The outer site zone is either non-existent or organised in concentric rows. Several large sites show a large central unbuilt area. In settlements of this pattern, radial streets cross frequently through all zones.

Related to the disintegration process of agglomerated Trypillia settlements and mega-sites, a **'degraded sub-type'** of the Trypillia layouts developed around 3650 BCE for the first time in the same regions. Although curved house rows still exist in these settlement plans, ring-corridors and zones are degraded to a large extent. Furthermore, plazas and mega-structures disappeared.

In several other respects also, these 'disintegrated' plans clearly mark the end of the 'classical' Trypillia layouts and the period of settlement agglomeration; settlements were already much smaller and the distances between houses larger. Highly-enlarged houses sizes might indicate changes in family size and subsistence economy.

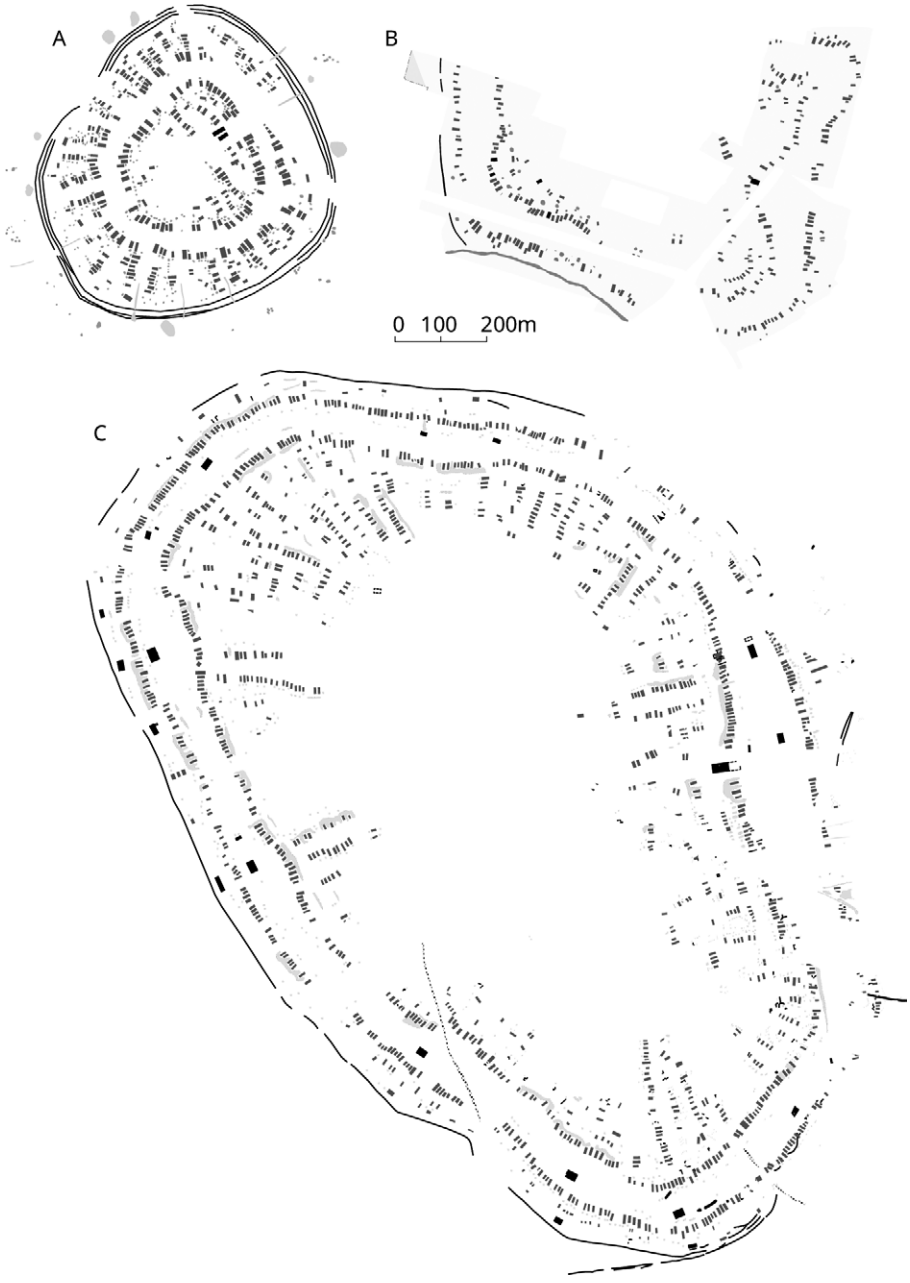


Figure 10. Regional patterns of Trypillia settlement plans: (A) West Trypillia pattern – Stolniceni 1 (after Ţerna et al. 2019), (B) Early East Trypillia pattern – Veselyj Kut, (C) Late West Trypillia pattern – Nebelivka (after Chapman et al. 2018).

In part, more advanced stages of disintegration may already be indicated by spatially separated house groups (single farmsteads) in Apolianka in the southern part of the surveyed area. These house groups may represent the proto-type of very small and simple **hamlets** which occurred in the same region and at the same time (Moshuriv 3, Cuncicea 1 and 4).

Centripetal and concentric settlement layouts: when, where and why?

Until now, the question of the origins, possible forerunners and circumstances under which the principle of ring-shaped Trypillia settlements developed was still unclear.

Just recently, newly discovered late Neolithic settlements layouts from Borđoš in the lower Tisza region and Iclot in Transylvania have been taken into consideration as

possible forerunners for the Trypillia type of settlements (Hofmann *et al.* 2019a). The above-mentioned settlements have, in common with the Trypillia-type of settlement layouts, round or oval ground plans and the orientation of houses towards the centre of the settlement. Furthermore, an unbuilt space is situated in the centre of settlements.

Corresponding so-called *centripetal* settlement layouts are documented in various regions and societies (Lee 2007). The spatial configuration involves numerous direct contacts with the settlement centre, which operates as a convex space of communication. Thus, the centripetal settlement configuration emphasises in particular the aspect of consensus-based communal decision-making and the negotiation of communal concerns as mechanisms to maintain social equality and balance.

Extremely important for our area of study is the fact that, besides the above-mentioned formal similarities, major differences can also be shown between late Neolithic settlements of Tisza and Carpathian region and Trypillia settlements. While late Neolithic settlements can best be characterised as *'centripetal'*, Trypillia settlements are better described as *'concentric' or ring-shaped*. While in the centripetal principle the central square played a major role as the central meeting point and the most frequented zone, the interaction in Trypillia settlements seems mainly focused on the ring-corridor. The central area of Trypillia settlements, in contrast, played no role in interactions at site level.

As a consequence, at Late Neolithic sites in the Carpathian Basin and Chalcolithic sites of the Trypillia period we are confronted with formally (in some aspects) similar but fundamentally different principles of settlement organisation (Fig. 11). Undoubtedly, the axial and widely visible character of Trypillia ring-corridors led to completely different interaction patterns within the settlement compared with the centripetal settlements of Late Neolithic in the Carpathian Basin. Communication was probably much more focused only on certain sections of the ring-structure and the related residents, leading at the same time to less common interaction on the level of the whole settlement. The inhabitants of these ring-street sections were integrated into various decentralised mega-structures.

Since we are dealing with fundamental different principles of settlement organisation, Carpathian settlements of the *'Balkan pattern'* can hardly be considered any more as forerunners of Trypillia ring-shaped settlements[1]. The same is true for the short curved house rows in some settlements of the Cucuteni type. From the point of view of interaction, these can hardly be compared with the effect on human agents of a ring-corridor running around an entire settlement. Thus, we should also exclude them as prototypes of Trypillia settlements.

In view of the specifics of the ring-shaped settlement layout and the failure of all other models discussed so far, we must consider the emergence of ring settlements from the internal dynamics of Trypillian societies. From this, there is new significance in the fact that just the earliest well-dated ring-shaped settlements Vilshanka, Zabolotne, and Veselyj Kut are the first agglomerated settlements. Consequently, according to currently available data, we need to assume the emergence of ring-shaped settlements after 4200 BCE at the earliest in the area between Dniester and Ros.

Ring-shaped settlements are therefore probably a phenomenon that arose in the context of the formation of agglomerated Trypillian villages. This new form of settlement should be seen as an expression of a new type of social organisation that allowed the coexistence of much larger communities in one site. Let us discuss which social strategies made possible the co-habitation of perhaps more than 10,000 people and what further social transformations can be deduced.

---

1 In the investigated sample only one centripetal settlement layout of Balkan type was proposed in Adâncata B (Cucutenti A3/Trypillia B1).

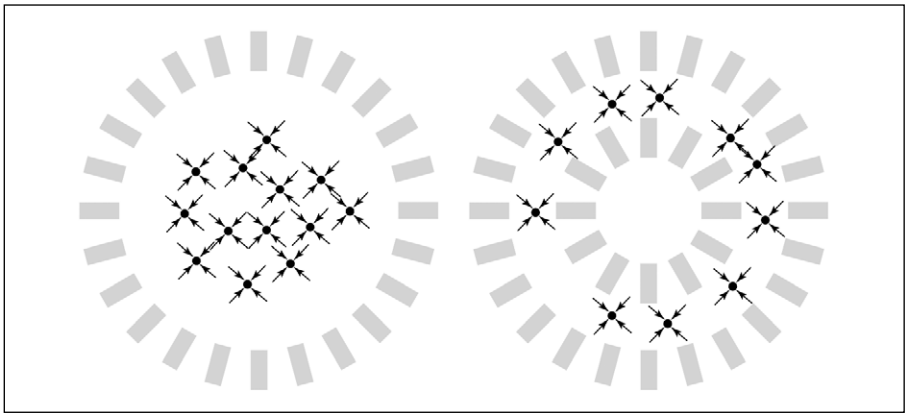


Figure 11. Centripetal (A) and ring-shaped (B) principle of settlement organisation. Dots and arrows illustrate meeting points.

What social transformations can be deduced from the development of the settlement plans?

For the social transformations that can be deduced from Trypillia settlement plans, the regionally and temporally different degrees of population agglomeration undoubtedly played a crucial role. The Trypillia agglomeration process started around 4200 BCE (Trypillia B1–B2) and lasted until about 3650 BCE. Geographically, we are dealing with the spatial concentration of extremely large settlements (up to 320 ha) in the area east of the Southern Bug River, while settlements further west mostly belong to an average-sized category (up to a maximum of 30 ha).

From a theoretical perspective, it is important to take into account that with a growing community size, additional political institutions usually emerge and social complexity increases, due to the limited ability of people to process information (Dunbar 1992; Johnson 1982; Johnson 1983; Bandy 2004; Alberti 2014). In order to manage this so-called 'scalar communication stress' and to maintain the ability to make decisions and achieve consensus, different mechanisms and strategies exist of which some are mentioned below and are discussed with regard to the Chalcolithic Trypillia communities studied:

1. Enlargement of families and other sub-units of societies
2. Establishment of sequential hierarchies (creating new decision-making levels)
3. Intensification of ritual, ceremonial and other integrative activities
4. Centralisation of power

The sociological term 'scalar communication stress' describes the mechanism of increasing in-group conflicts in parallel to the increase in group sizes. It is considered as one of the causes for the emergence of social inequality and complexity, since emerging leadership is able to solve scale-related social problems.

The settlement plans examined will be discussed with regard to these aspects.

As a proxy for **the size of contemporary residential units** (*e.g.* households, families) the size of contemporary dwellings is considered in a long-term perspective. For our study, this is relevant insofar as an increase in family sizes was observed under conditions of scalar communication stress (Johnson 1982). This is explained as a possible reason to reduce the operational size of these units and thus make the number of units in the system smaller.

That floor sizes can be used to estimate the size of households and families has been empirically confirmed by a frequently used cross-cultural ethnographic sample which shows the correlation between house size and number of inhabitants (*e.g.* Naroll 1962; Brown 1987). However, caution is required insofar as the size of residential units may not automatically be equated with families or households. In reality, several additional factors may play a role for the actual variability of houses

sizes, such as residential behaviour, degree of mobility and probably also economic factors (*e.g.* Porčić 2010; Porčić 2012; Hofmann 2015).

In our sample of Trypillia plans, the theoretical expectations with regard to the development of house sizes are not fulfilled, since there is no significant increase in house sizes in relation to the formation of large sites. Rather, we observe a slight decrease in house size and thereby an opposite trend. To make matters more problematic, a significant increase in the size of houses can be observed associated only with the disintegration of large agglomerated settlements.

As we do not want to look more deeply into this problem in this contribution, only two comments on this are made. On the one hand, we cannot really rule out the possibility that households were distributed across several neighbouring houses. This could for example explain to some extent the clustering or grouping of houses. On the other hand, very similar trajectories seen in Trypillia were observed as related also to other processes of population agglomeration and dispersal (*e.g.* Hofmann 2015).

For the social-historical interpretation of the settlement plans, the **integrative architecture of mega-structures** is of enormous importance insofar as it seems to reflect the social organisation and decision-making structure in Cucuteni-Trypillia settlements (Müller *et al.* 2016b; Hofmann *et al.* 2019b). While smaller settlements contained only central mega-structures for the entire settlement, mega-sites like Maidanetske, Volodymyrivka and Nebelivka exhibit at least three different levels of such buildings, for both high-level mega-structure for the whole community and low-level ones for certain parts of the population. The widespread intra-site distribution of low-level mega-structures is interpreted as a sequential hierarchy in decision-making and integrative actions.

Mega-structures already existed in settlements from the first half of the 5th millennium BCE. In early agglomerated ring-shaped settlements of the periods Trypillia B1–B2, central mega-structures are part of the inner house ring of the ring-corridor. There, they are integrated side by side with normal residential houses into the same building line. In this early stage, there are no cases of clearly formed plazas demarcated by houses in settlements west of the Southern Bug. This might suggest that initially normal dwellings or non-architecturally differentiated buildings might have been used for integrative activities, before specialised buildings were developed for these purposes.

The emergence of this distributed sequential social organisation is seen related to the formation of mega-sites and reflects most likely the planned and equal fusion of different communities into giant settlements. Obviously, these communities maintained their (old) integrative institutions and established new high-level central institutions for the entire settlement.

A comparative regional view of the distribution of mega-structures shows that settlements without this multiple sequence of decision-making levels were generally considerably smaller than those that possessed them. We argue that the described hierarchical organisation of different mega-structure levels was a prerequisite to maintain everyday and social life in the large Chalcolithic mega-sites. Therefore, our model provides a plausible explanation for pronounced regional differences in settlement size. While in the Southern Bug-Dnieper interfluve (Region A), institutions at different levels could be established through the decision to fuse and integrate several settlements in large mega-sites, comparable fusions were either not done, not done in the same scale, or were done in a different way in the regions west of the Southern Bug (Regions B and C).

Very enlightening also is to view the sequence of sites with decentralised mega-structures in a longer-term perspective. As is indicated by reverses in the size and architectural development of mega-structures in different positions, loosening of the integration at the level of sub-communities gained more and more importance (Hofmann *et al.* 2019b). High-level integrative institutions, in contrast, became more

important, as is for example indicated by the growing dimensions of the buildings with increasingly differentiated architecture and partly monumental character. We interpret this loss of importance of low-level institutions and the increase in importance of the central institution for the entire settlement as an indicator of the involvement of less and less people in the decision-making processes.

The observed transition from decentralised decision-making in multiple small mega-structures towards considerably more centralised political conditions towards the end of the sequence of Trypillia mega-sites might indicate the emergence of certain hierarchies. In our view, scalar stress resulting from dysfunctional collective decision-making and the non-acceptance of emerging hierarchies could have been important factors for the failure of Trypillia mega-sites (Hofmann *et al.* 2019b).

Another category of integrative mechanism concerns **ceremonial or ritual actions**. Different attempts to reconstruct this kind of activities for Trypillian societies have already been undertaken, including for example the use of anthropomorphic and zoomorphic figurines, deliberate house burning, depositional practices in houses and pits, feasting, dancing, or the use of temples, *etc.*

All such theories can hardly be seen as other than assumptions due to the lack of other sources (*e.g.* written ones). For this reason, we propose to look at the 'ritual sphere' in a wider sense, which implies that this kind of activity is one necessary part of integrative actions. Thus, we understand ritual and ceremonial activity as an important integrative mechanism, which was absolutely necessary and crucial for the functioning of these large villages, akin to shopping in capitalistic societies, or war memory for example in socialist countries.

The intensity of integrative ceremonial activities is generally scale-dependent, as has been proven by ethnographic observations (Johnson 1982). Accordingly, only in very large settlements can particularly intensive ceremonial activity be assumed.

Within mega-structures of the Southern Bug-Dnieper interfluve we could for example localise integrative activities in mega-structures. Since mega-structures shared the same space with primary plazas and the ring-corridor, these are the places where we can also localise other such integrative activities outside of these buildings. If in addition we take into consideration that plazas were already known in much smaller-scale Cucuteni settlements, then the ring-corridor becomes a particular focus for us, as it emerged at the same time as large agglomerated sites.

The ring-corridor has proved to represent an absolutely basic and consistently-occurring key component of all agglomerated Trypillia settlements which immediately disappeared with the disintegration of large sites. Additionally, mega-structures appeared in the ring-corridor. Since the multiple occurrences of these integrative buildings is probably the result of actions common to different communities, the ring-corridor of large settlements can be understood as a built expression of the mutual agreement between these communities and as a manifestation of the integrative concept of these settlements.

Because of all that we have set out above, we think that the concept of ring-shaped settlement layout is directly related to the population agglomeration and the phenomenon of large sites.

Moreover, the following aspects seem to be important. As was already highlighted, in Trypillia societies there is an overall lack of signs of centralised power and other possible kinds of integrative indicators such as temples, monumental architecture and wealth accumulation. Thus, other additional mechanisms have to be assumed to maintain this level of equality and balance.

The importance of the ring-corridor is also indicated by its large dimensions, which were scaled up and adopted according the settlement sizes. From today's point of view, the large width of these corridors does not seem to fulfil a particular practical function. Because of this, we believe that the ring-corridor might be the focal point for different kinds of integrative action that took place, including ceremonies and rituals, in the wider sense.

Conclusions

The period of the Eneolithic on the territory between the east Carpathian and the Dnieper is represented by Cucuteni-Trypillia sites (4700–3000 BCE). Settlement layouts of this cultural complex are not homogeneous. As a minimum, two basic patterns could be distinguished – the Cucuteni and the Trypillia pattern. Cucuteni sites are characterised by small size, unimodal or bimodal oriented houses and often by rectangular plazas with mega-structures. In contrast, Trypillia sites show a clear zonal structure with the main zone consisting of two concentric house rings and a ring-corridor in between. In large sites, frequently high-level and low-level mega-structures occur in the main plaza and are distributed in the ring-street and other places. Houses of the inner and outer site zones follow in their orientation the ring-corridor. We propose to call such layouts 'ring-shaped' or 'concentric'.

For the analysis of settlement structures, site planes were divided in four hierarchical levels – elements, groups of elements, created space components and site zones. Almost all of these levels have their own chronological and geographical specifics. For example, quarter-like house arrangements were observed mainly in the western part of the Trypillia distribution (Petreni, Stolniceni Trypillia B2/C1), while mega-structures in the ring-corridor are mainly known from the region east of the Southern Bug.

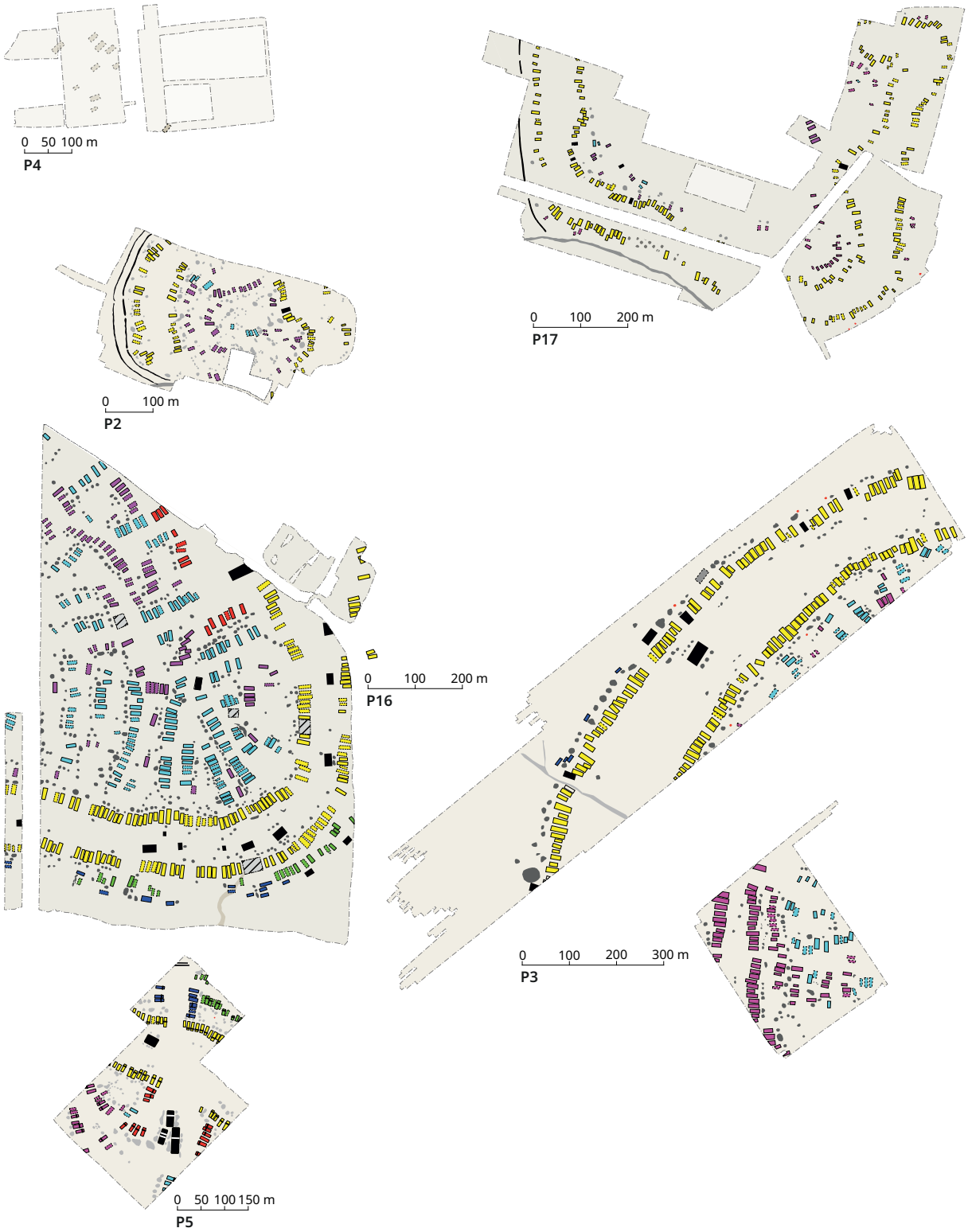
Our analysis demonstrates very clearly that the concentric ring-street represents the key-element of Trypillia sites. Moreover, the occurrence and development of this ring-zone is directly connected with the process of Trypillia settlement agglomeration. Thus, we believe that the Trypillia layout is directly connected with large settlements. So far, no direct or indirect Neolithic or Chalcolithic analogies could be identified in the Balkans and other neighbouring areas, which is why we think this layout evolved in relation to the Trypillian population agglomeration process. However, it is necessary to highlight that, without doubt, some institutions were already present in sites of the Cucuteni-type (central mega-structure and associated plaza).

With the later agglomerated settlements, ring-shaped configurations were replaced by a 'degraded' Trypillia layout. Visually, these final Trypillian sites still show some remains of the former spatial organisation, such as curved house rows. But most of the components and elements, which in our opinion are connected with integrative actions (ring-corridor, plazas, mega-structures) have disappeared completely. Consequently, this sub-type of layout can be directly related to the process of disintegration of agglomerated Trypillia settlements. Together with this type, a new small hamlet-like settlement type appeared.

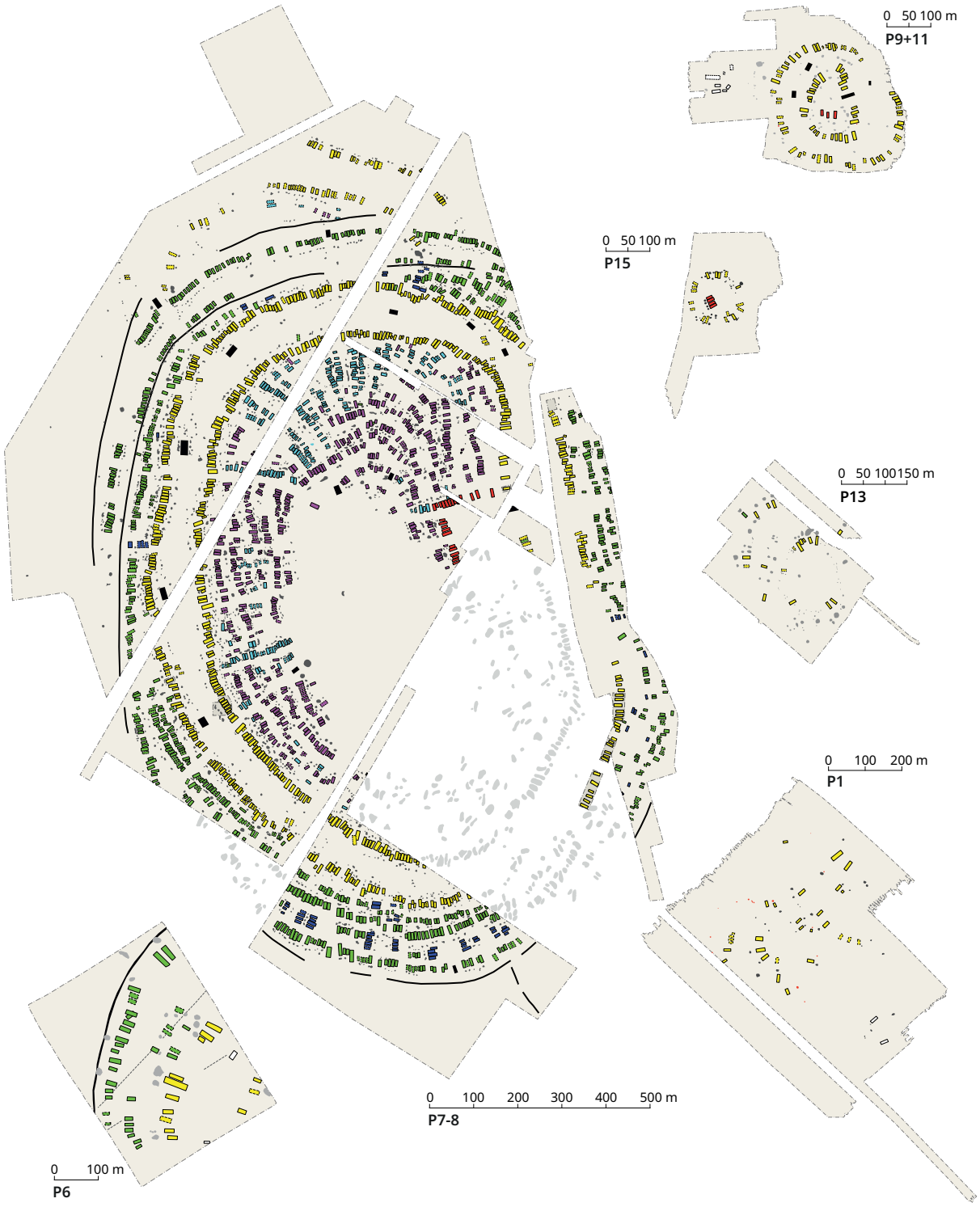
We have shown the basic trends in the development of Cucuteni-Trypillia settlement layouts and have outlined social-historical interpretations of this trajectory. In view of the many unclear details and the ongoing devastation of Trypillia sites through intensive agriculture, further investigation and the continuation of surveys are urgently needed in the study region and beyond.

Acknowledgements

This research was funded by the DFG Collaborative Research Centre CRC1266 'Scales of Transformation – Human-Environmental Interaction in Prehistoric and Archaic Societies' (German Research Foundation – Project number 290391021 – SFB1266).



Plans A1: Settlement plans of the Southern-Bug-Dnieper interfluve (study region A). The numbering of the plans refers to the plan-id in Table 1: P2 – Chyzhivka; P3 – Dobrovody; P4 – Grebenyukiv Yar; P5 – Hlybochok; P16 – Volodymyrivka; P17 – Veselyj Kut.



Plans A2: Settlement plans of the Southern-Bug-Dnieper interfluve (study region A). The numbering of the plans refers to the plan-id in Table 1: P1 – Apolianka; P6 – Kosenovka; P7-8 – Maidanetske A and B; P9 and 11 – Moshuriv 1 and Moshuriv 3; P13 – Rohy; P15 – Talne 3.



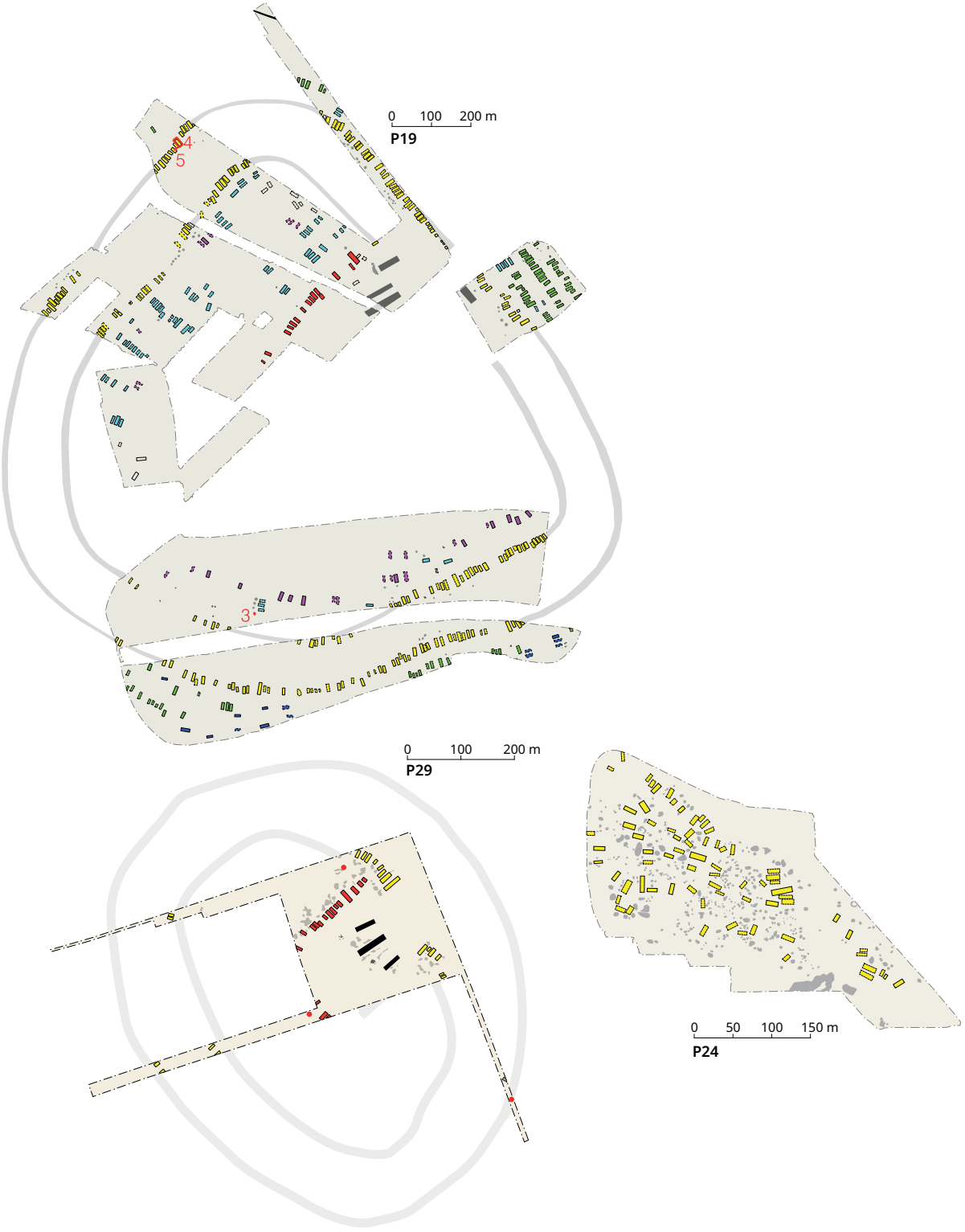
Plans A3: Settlement plans of the Southern-Bug-Dnieper interfluve (study region A). The numbering of the plans refers to the plan-id in Table 1: P12 – Nebelivka.



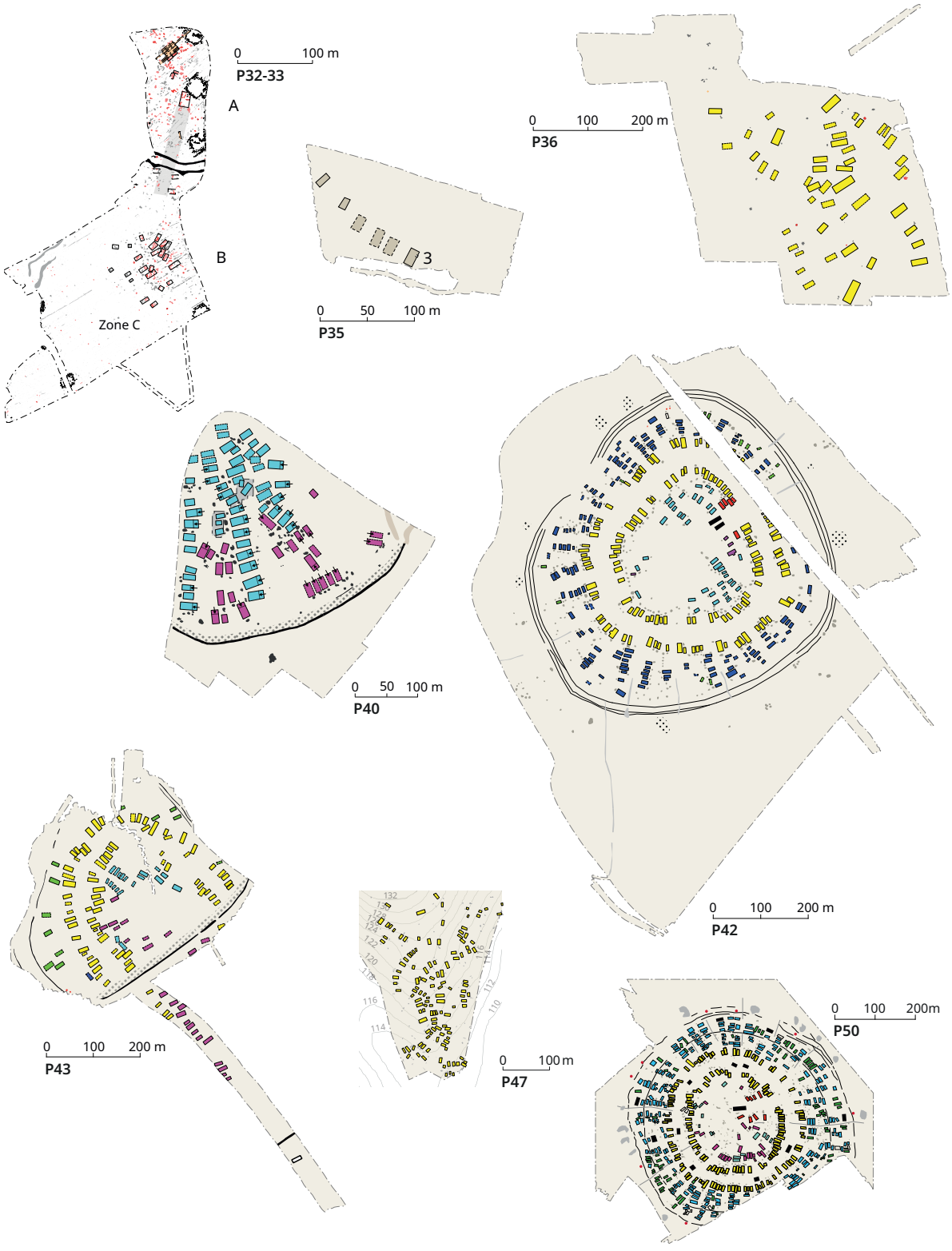
Plans A4: Settlement plans of the Southern-Bug-Dnieper interfluve (study region A). The numbering of the plans refers to the plan-id in Table 1: P14 – Talianki.



Plans B1: Settlement plans of the Bug-Dniester interfluve (study region B). The numbering of the plans refers to the plan-id in Table 1: P18 – Bernashivka 1; P21 – Gariachkivka 3; P22 – Gariachkivka 7; P23 – Gariachkivka 8; P26 – Ternivka; P27 – Trostianchyk; P28 – Vilshanka; P31 – Zabolotne.



Plans B2: Settlement plans of the Bug-Dniester interfluve (study region B). The numbering of the plans refers to the plan-id in Table 1: P19 – Bilyi Kamin; P24 – Kisnytsia; P29 – Viitivka.



Plans C1: Settlement plans of the Prut-Dniester interfluve (study region C). The numbering of the plans refers to the plan-id in Table 1: P32–33 – Adâncata A and B; P35 – Cunicea 1; P36 – Cunicea 3; P40 – Putinești 3; P42 – Stolniceni 1; P43 – Trinca; P47 – Sîngerei-La Cazasu; P50 – Petreni I.

References

Alberti, G., 2014. Modeling Group Size and Scalar Stress by Logistic Regression from an Archaeological Perspective. *PLoS ONE*, 9 (3), e91510. Available from: DOI:10.1371/journal.pone.0091510

Asăndulesei, A., 2017. Inside a Cucuteni Settlement: Remote Sensing Techniques for Documenting an Unexplored Eneolithic Site from Northeastern Romania. *Remote Sensing*, 9 (1), 41. Available from: DOI:10.3390/rs9010041

Bandy, M.S., 2004. Fissioning, Scalar Stress, and Social Evolution in Early Village Societies. *American Anthropologist*, 106 (2), 322–333. Available from: DOI:10.1525/aa.2004.106.2.322

Boghian, D., Asăndulesei, A., Tencariu, F.-A., Melniciuc, A. and Enea, S.-C., 2016. Magnetometric survey and archaeological realities in the site of Ripiceni-'Holm' (Botoșani County, Romania). *In*: D. Mischka, C. Mischka and C. Preoteasa, eds. *Beyond Excavation. Geophysics, Aerial Photography and the Use of Drones in Eastern and Southeastern European Archaeology. Proceedings of the International Colloquium, 5-8 December 2016, Piatra-Neamț, Romania*. Bibliotheca Memoriae Antiquitatis 40; Erlanger Studien zur Prähistorischen Archäologie 3. Piatra-Neamț: Editura "Constantin Matasă", 55–57.

Brown, B.M., 1987. Population Estimation from Floor Area: A Restudy of "Naroll's Constant". *Behavior Science Research*, 21 (1–4), 1–49. Available from: DOI:10.1177/106939718702100101

Burdo, N. and Videiko, M., 2016. Nebelivka: From Magnetic Prospection to New Features of Mega-Sites. *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE.* Themes in Contemporary Archaeology 2. London, New York: Routledge, 95–116. Available from: DOI:10.4324/9781315630731

Chabanyuk, V.V., 2008. New experimental data on the Tripolye house construction techniques. *In*: A. Korvin-Piotrovskiy and F. Menotti, eds. *Tripolye Culture in Ukraine: The Giant-Settlement of Talianki*. Kiev: Institute of Archaeology of the National Academy of Sciences of Ukraine, 218–226.

Chapman, J., Videiko, M., Gaydarska, B., Burdo, N., Hale, D. Villis, R., Swann, N., Thomas, N., Edwards, P., Blair, A., Hayes, A., Nebbia, M. and Rud, V., 2014a. The planning of the earliest European proto-towns: a new geophysical plan of the Trypillia mega-site of Nebelivka, Kirovograd Domain, Ukraine. *Antiquity*, 88 (339), Project Gallery.

Chapman, J., Videiko, M.Y., Hale, D., Gaydarska, B., Burdo, N., Rassmann, K., Mischka, C., Müller, J., Korvin-Piotrovskiy, A. and Kruts, V., 2014b. The Second Phase of the Trypillia Mega-Site Methodological Revolution: A New Research Agenda. *European Journal of Archaeology*, 17 (3), 369–406. Available from: https:doi.org/10.1179/1461957114Y.0000000062

Chapman, J., Gaydarska, B. and Hale, D., 2016. Nebelivka: Assembly Houses, Ditches, and Social Structure. *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE.* Themes in Contemporary Archaeology 2. London, New York: Routledge, 117–131. Available from: DOI:10.4324/9781315630731

Chapman, J.C., Gaydarska, B. Nebbia, M. Millard, A. Albert, B. Hale, D. Woolston-Houshold, M. Johnston, S. Caswell, E. Arroyo-Kalin, M. Kaikkonen, T. Roe, J. Boyce, A. Craig, O. Orton, D.C. Hosking, K. Rainsford-Betts, G. Nottingham, J. Miller, D. Arbeiter, S. Shevchenko, N. Pashkevytch, G. Rud, V. Videiko, M.Y. Burdo, N. and Krementski, K., 2018. *GEOINFORM Ukrainii. Trypillia mega-sites of the Ukraine* [dataset]. York: Archaeology Data Service [distributor]. Available from: DOI:10.5284/1047599

Chernovol, D., 2012. Houses of the Tomashovskaya Local Group. *In*: F. Menotti and A.G. Korvin-Piotrovskiy, eds. *The Tripolye Culture Giant-Settlements in Ukraine. Formation, Development and Decline*. Oxford: Oxbow Books, 183–209. Available from: DOI:10.2307/j.ctvh1dvmn.13

Chernovol 2016: Черновол, Д., 2016. Поселение трипольской культуры Бернашевка I. *Revista Archeologică*, 12 (1–2), 61–80.

Diachenko, A., 2016. Demography Reloaded. *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE.* Themes in Contemporary Archaeology 2. London, New York: Routledge, 181–193. Available from: DOI:10.4324/9781315630731

Dudkin 1968: Дудкин, В.П., 1968. Геофизическая разведка на позднетрипольском поселении у с. Маяки. *In*: П.П. Толочко, ed. Археологические исследования на Украине в 1967 г., Vol. II. Киев: Издательство «Наукова думка», 216–219.

Dumitrescu, V., 1963. Originea si evolutia culture Cucuteni-Tripolye (II). *Studii şi cercetări de istorie veche*, 14 (2), 285–305.

Dumitrescu, V., 1972. În legătură cu periodizarea fazei Cucuteni A-B. *Studii şi Cercetări de Istorie Veche şi Arheologie*, 23 (3), 441–447.

Dunbar, R.I.M., 1992. Neocortex size as a constraint on group size in primates. *Journal of Human Evolution*, 22 (6), 469–493. Available from: DOI:10.1016/0047-2484(92)90081-J

Gaydarska, B., Nebbia, M. and Chapman, J., 2019. Trypillia Megasites in Context: Independent Urban Development in Chalcolithic Eastern Europe. *Cambridge Archaeological Journal*, 30 (1), 97–121. Available from: DOI:10.1017/S0959774319000301

Harper, T.K., Diachenko, A., Rassamakin, Y.Y., Chernovol, D.K., Shumova, V.A., Nechitailo, P., Chabaniuk, V.V., Tsvek, E.V., Bilas, N.M., Pohoralskyi, Y.V., Eccles, L.R., Kennett, D.J. and Ryzhov, S.N., 2021. Combining relative chronology and AMS ^{14}C dating to contextualize 'megasites', serial migrations and diachronic expressions of material culture in the Western Tripolye culture, Ukraine. *Documenta Praehistorica*, 48, 276–296. Available from: DOI:10.4312/dp.48.11

Harper, T.K., Diachenko, A., Ryzhov, S.N., Rassamakin, Y.Y., Eccles, L.R., Kennett, D.J. and Tsvek, E.V., 2023. Assessing the spread of Eneolithic agricultural communities in the forest-steppe of Ukraine using AMS radiocarbon dating. *Radiocarbon*, 65 (3), 643–663. Available from: DOI:10.1017/RDC.2023.28

Hofmann, R., 2015. The Bosnian Evidence: The New Late Neolithic and Early Copper-Age Chronology and Changing Settlement Patterns. *In*: S. Hansen, P. Raczky, A. Anders and A. Reingruber, eds. *Neolithic and Copper Age between the Carpathians and the Aegean Sea. Chronologies and Technologies from the 6th to the 4th Millenium BCE. International Workshop Budapest 2012*. Archäologie in Eurasien 31. Bonn: Dr. Rudolf Habelt, 219–241.

Hofmann, R., Țerna, S., Rud, V., Shatilo, L. and Sîrbu, G., 2016a. Geomagnetic Surveys and Test-Trenches on Early Neolithic – Late Copper Age sites from Republic of Moldava: international colloquium: programme and abstracts. *In*: D. Mischka, C. Mischka and C. Preoteasa, eds. *Beyond Excavation. Geophysics, Aerial Photography and the Use of Drones in Eastern and Southeastern European Archaeology. Proceedings of the International Colloquium, 5-8 December 2016, Piatra-Neamț, Romania*. Bibliotheca Memoriae Antiquitatis 40; Erlanger Studien zur Prähistorischen Archäologie 3. Piatra-Neamț: Editura "Constantin Matasă", 18–22.

Hofmann, R., Țerna, S., Ursu, C.-E., Brandtstätter, L., Tiede, H., Mainusch, W. and Authenrieth, S., 2016b. Spatial organization and population size of small Cucuteni-Tripolye settlements: Results of geomagnetic surveys in Baia and Adâncata, Suceava County, Bucovina, Eastern Romania. *Journal of Neolithic Archaeology*, 18, 157–189. Available from: DOI:10.12766/jna.2016.4

Hofmann, R., Shatilo, M., Ohlrau, R., Dal Corso, M., Dreibrodt, S., Videiko, M., Rassmann, K., Kirleis, W. and Müller, J., 2018. Tripolye – Strategy and Results of an ongoing Ukrainian-European Project. *Vita Antiqua*, 10, 146–154. Available from: DOI:10.37098/2519-4542-2018-1-10-146-154

Hofmann, R., Medović, A., Furholt, M., Medović, I., Stanković-Pešterac, T., Dreibrodt, S., Martini, S. and Hofmann, A., 2019a. Late Neolithic multicomponent sites of the Tisza region and the emergence of centripetal settlement layouts. *Praehistorische Zeitschrift*, 94 (2), 351–378. Available from: DOI:10.1515/pz-2019-0003

Hofmann, R., Müller, J., Shatilo, L., Videiko, M., Ohlrau, R., Rud, V., Burdo, N., Dal Corso, M., Dreibrodt, S. and Kirleis, W., 2019b. Governing Tripolye: Integrative architecture in Tripolye settlements. *PLoS ONE*, 14 (9), e0222243. Available from: DOI:10.1371/journal.pone.0222243

Hofmann, R., Müller-Scheeßel, N. and Müller, J., 2024. Trypillia mega-sites: a social levelling concept? *Antiquity*, 98 (398), 380–400. Available from: DOI:10.15184/aqy.2024.18

Johnson, G.A., 1982. Organizational Structure and Scalar Stress. *In*: C. Renfrew, M.J. Rowlands and B.A. Segraves, eds. *Theory and Explanation in Archaeology: The Southampton Conference*. New York, London: Academic Press, 389–421.

Johnson, G.A., 1983. Decision-Making Organization and Pastoral Nomad Camp Size. *Human Ecology*, 11 (2), 175–199. Available from: DOI:10.1007/BF00891742

Korvin-Piotrovskiy 2015: Корвин-Пиотровский, А.Г., 2015. «Мегаструктуры» на поселениях гигантах Трипольской Культуры: Варианты интерпретаций. *In*: М.Ю. Відейко, Д. Чапман, І.А. Козир and В.В. Собчук, eds. На східній межі старої Європи / *At the Eastern frontiers of Old Europe.* Матеріали міжнародної наукової конференції, Кіровоград, Небелівка, 12–14 травня 2015 року. Кіровоград: Кіровоградська обласна державна адміністрація и друг, 19–20.

Korvin-Piotrovskiy and Ovchinnikov 2020: Корвин-Пиотровский, А.Г. and Овчинников, Э.В., 2020. Виробничі об'єкти комплексу «Сім'я гончара» на трипільському поселенні Тальянки. Емінак, 25 (1), 254–276.

Korvin-Piotrovskiy, A.G., Chabanyuk, V. and Shatilo, L., 2012. Tripolian House Construction: Concepts and Experiments. *In*: F. Menotti and A.G. Korvin-Piotrovskiy, eds. *The Tripolye Culture Giant-Settlements in Ukraine. Formation, Development and Decline*. Oxford: Oxbow Books, 210–229. Available from: DOI:10.2307/j.ctvh1dvmn.14

Korvin-Piotrovskiy, A., Hofmann, R., Rassmann, K., Videiko, M.Y. and Brandtstätter, L., 2016. Pottery Kilns in Trypillian Settlements. Tracing the Division of Labour and the Social Organization of Copper Age Communities. *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE.* Themes in Contemporary Archaeology 2. London, New York: Routledge, 221–252. Available from: DOI:10.4324/9781315630731

Koshelev 2004: Кошелев, И.Н., 2004. Памятники трипольской культуры (по данным магнитной разведки). Киев: Самиздат.

Kruts 1989: Круц, В.А., 1989. К истории населения трипольской культуры в междуречье Южного Буга и Днепра. *In*: С.С. Березанская, ed. Первобытная археология. Материалы и исследования. Київ: Издательство «Наукова думка», 117–132.

Kruts, V., 2012. Giant-settlements of Tripolye culture. *In*: F. Menotti and A.G. Korvin-Piotrovskiy, eds. *The Tripolye Culture Giant-Settlements in Ukraine. Formation, Development and Decline*. Oxford: Oxbow Books, 70–78. Available from: DOI:10.2307/j.ctvh1dvmn.8

Kruts *et al.* 2005: Круц, В.А., Корвин-Пиотровский, А.Г., Рыжов, С.Н., Бузян, Г.Н., Овчинников, Э.В., Черновол, Д.К. and Чабанюк, В.В., eds., 2005. Исследование поселений-гигантов трипольской культуры в 2002-2004 гг. Киев: Институт археологии НАН Украины.

Kruts, V., Korvin-Piotrovskiy, A.G., Mischka, C., Ohlrau, R., Windler, A. and Rassmann, K., 2013. The Geomagnetic Prospection. *In*: A.G. Korvin-Piotrovskiy and K. Rassmann, eds. *Talianki – Settlement-Giant of the Tripolian Culture. Investigations in 2012*. Kiev: Institute of Archaeology of the National Academy of Sciences of Ukraine, 85–103.

Lee, Y.K., 2007. Centripedal settlement and segmentary social formation of the Banpo tradition. *Journal of Anthropological Archaeology*, 26 (4), 630–675. Available from: DOI:10.1016/j.jaa.2007.03.001

Menotti, F. and Korvin-Piotrovskiy, A.G., eds., 2012. *The Tripolye Culture Giant-Settlements in Ukraine. Formation, Development and Decline*. Oxford: Oxbow Books. Available from: DOI:10.2307/j.ctvh1dvmn

Mischka, C., Mischka, D. and Rubel, A., 2016. Geomagnetic Survey of Cucuteni-Settlements in Moldova – Results of the FAU Campaign 2015. *Arheologia Moldovei*, 39, 333–345.

Mischka, C., Preoteasa, C. and Schafferer, G., 2019. Gradiometerprospektionen auf Fundplätzen der Cucuteni-Kultur im Kreis Neamţ (Rumänien). Ergebnisse der Jahre 2015 und 2016. *Eurasia Antiqua*, 22 (2016), 115–131.

Müller, J., Hofmann, R., Brandtstätter, L., Ohlrau, R. and Videiko, M., 2016a. Chronology and Demography: How Many People Lived in a Mega-Site? *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE.* Themes in Contemporary Archaeology 2. London, New York: Routledge, 133–170. Available from: DOI:10.4324/9781315630731

Müller, J., Hofmann, R. and Ohlrau, R., 2016b. From Domestic Households to Mega-Structures: Proto-Urbanism? *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE.* Themes in Contemporary Archaeology 2. London, New York: Routledge, 253–268. Available from: DOI:10.4324/9781315630731

Müller, J., Rassmann, K. and Videiko, M., eds., 2016c. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE.* Themes in Contemporary Archaeology 2. London, New York: Routledge. Available from: DOI:10.4324/9781315630731

Müller, J., Hofmann, R., Kirleis, W., Dreibrodt, S., Ohlrau, R., Brandtstätter, L., Dal Corso, M., Out, W., Rassmann, K., Burdo, N. and Videiko, M., eds., 2017. *Maidanetske 2013. New excavations at a Trypillia mega-site* / Майданецьке *2013.* Нові розкопки великого Трипільського поселення. Studien zur Archäologie in Ostmitteleuropa 16. Bonn: Dr. Rudolf Habelt.

Müller, J., Hofmann, R., Ohlrau, R. and Shatilo, M., 2018. The social constitution and political organisation of Tripolye mega-sites: hierarchy and balance. *In*: H. Meller, D. Gronenborn and R. Risch, eds. Überschuss ohne Staat – Politische Formen in der Vorgeschichte. *10. Mitteldeutscher Archäologentag vom 19. bis 21. Oktober 2017 in Halle (Saale)* / *Surplus without the State – Political Forms in Prehistory. 10th Archaeological Conference of Central Germany, October 19–21, 2017 in Halle (Saale).* Tagungen des Landesmuseums für Vorgeschichte Halle 18. Halle/Saale: Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt – Landesmuseum für Vorgeschichte, 247–262.

Naroll, R., 1962. Floor area and settlement population. *American Antiquity*, 27 (4), 587–589. Available from: DOI:10.2307/277689

Nebbia, M., Gaydarska, B., Millard, A. and Chapman, J., 2018. The making of chalcolithic assembly places: Trypillia megasites as materialized consensus among equal strangers? *World Archaeology*, 50 (1), 41–61. Available from: DOI:10.1080/00438243.2018.1474133

Ohlrau, R., 2015. Trypillia Großsiedlungen: Geomagnetische Prospektion und architektursoziologische Perspektiven. *Journal of Neolithic Archaeology*, 17, 17–100. Available from: DOI:10.12766/jna.2015.3

Ohlrau, R., 2020. *Maidanets'ke: Development and decline of a Trypillia mega-site in Central Ukraine*. Scales of Transformation in Prehistoric and Archaic Societies 7. Leiden: Sidestone Press. Available from: DOI:10.59641/h0912kt

Ohlrau, R. and Rud, V., 2019. Testing Trypillian site development via geomagnetic survey – New "mega-structures" and plans of smaller sites. *In*: D. Mischka, C. Mischka and C. Preoteasa, eds. *Beyond Excavation. Geophysics, Aerial Photography and the Use of Drones in Eastern and Southeastern European Archaeology. Proceedings of the International Colloquium, 5-8 December 2016, Piatra-Neamț, Romania*. Bibliotheca Memoriae Antiquitatis 40; Erlanger Studien zur Prähistorischen Archäologie 3. Piatra-Neamț: Editura "Constantin Matasă", 87–113.

Passek 1949: Пассек, Т.С., 1949. Периодизация трипольских поселений *(III–II* тыс. до н.э*.)*. Материалы и исследования по археологии СССР (МИА) 10. Москва, Ленинград: Издательство Академии наук СССР.

Petrescu-Dîmboviţa, M., Florescu, M. and Florescu, A.C., 1999. *Trusesti: monografie arheologicǎ*. Bucuresti: Editura Academiei Române.

Pickartz, N., Hofmann, R., Dreibrodt, S., Rassmann, K., Shatilo, L., Ohlrau, R., Wilken, D. and Rabbel, W., 2019. Deciphering archeological contexts from the magnetic map: Determination of daub distribution and mass of Chalcolithic house remains. *The Holocene*, 29 (10), 1637–1652. Available from: DOI:10.1177/0959683619857238

Porčić, M., 2010. House Floor Area as a Correlate of Marital Residence Pattern: A Logistic Regression Approach. *Cross-Cultural Research*, 44 (4), 405–424. Available from: DOI:10.1177/1069397110378839

Porčić, M., 2012. Effects of Residential Mobility on the Ratio of Average House Floor Area to Average Household Size: Implications for Demographic Reconstructions in Archaeology. *Cross-Cultural Research*, 46 (1), 72–86. Available from: DOI:10.1177/1069397111423889

Przybyła, M.M., Sîrbu, G., Rybicka, M., Król, D. and Sîrbu, L., 2017. Some Results of the Geophysical Investigation at the Late Eneolithic Settlement of Gordineşti II-*Stînca goală*, Edineț District, Republic of Moldova. *Analecta Archaeologica Ressoviensia*, 12, 49–58. Available from: DOI:10.15584/anarres.2017.12.4

Rassmann, K., Ohlrau, R., Hofmann, R., Mischka, C., Burdo, N., Videjko, M.Y. and Müller, J., 2014. High precision Tripolye settlement plans, demographic estimations and settlement organization. *Journal of Neolithic Archaeology*, 16, 96–134. Available from: DOI:10.12766/jna.2014.3

Rassmann, K., Korvin-Piotrovskiy, A., Videiko, M. and Müller, J., 2016a. The new Challenge for Site Plans and Geophysics: Revealing the Settlement Structure of Giant Settlements by Means of Geomagnetic Survey. *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE.* Themes in Contemporary Archaeology 2. London, New York: Routledge, 29–54. Available from: DOI:10.4324/9781315630731

Rassmann, K., Mertl, P., Voss, H.-U., Bicbaev, V., Popa, A. and Musteaţă, S., 2016b. Copper Age Settlements in Moldova: Insights into a Complex Phenomenon from Recent Geomagnetic Surveys. *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE.* Themes in Contemporary Archaeology 2. London, New York: Routledge, 55–70. Available from: DOI:10.4324/9781315630731

Rud *et al.* 2018: Рудь, В., Улрау, Р., Федоров, С. and Зайцева, О., 2018. Дослідження на поселеннях Трипільської культури Тростянчик та Війтівка. Археологічні дослідження в Україні, 2016, 11–14.

Rud, V., Hofmann, R., Kosakivskyi, V., Zaitseva, O. and Müller, J., 2019a. Trypillia Megasites West of the River Southern Buh: Preliminary Results of Bilyi Kamin Site Investigation in 2018. *Journal of Neolithic Archaeology*, 21, 27–60. Available from: DOI:10.12766/jna.2019.2

Rud, V., Zaitseva, O., Hofmann, R., Rauba-Bukowska, A. and Kosakivsky, V., 2019b. Unique Pottery Kiln Construction? The Interpretation of Massive Clay Objects from the Trostianchyk Site of the Trypillia Culture. *Sprawozdania archeologiczne*, 71, 11–39. Available from: DOI: 10.23858/sa71.2019.001

Rud *et al.* 2021: Рудь, В., Хофманн, Р. and Косаківський, В., 2021. Магнітні аномалії лінійного характеру на поселеннях Трипілля ВII Тростянчик та Ворошилівка. *In*: A. Diachenko, T.K. Harper, Y. Rassamakin and I. Sobkowiak-Tabaka, eds. *Data Systematization in the Neo-Eneolithic of Southeastern and Central Europe. Essays in honor of Sergej Ryzhov* / Систематизація неолітичних і енеолітичних матеріалів Південно-Східної та Центральної Європи. Збірка наукових праць на пошану Сергія Рижова. Kyiv: Institute of Archaeology of the National Academy of Sciences of Ukraine, 246–264.

Ryzhov 1990: Рыжов, С.Н., 1990. Микрохронология трипольского поселения у с. Тальянки. *In*: В.Г. Збенович *et al.*, eds. Раннеземледельческие поселения-гиганты трипольской культуры на Украине. Тез. докл. 1-го полевого семинара. Тальянки, Веселый Кут, Майданецкое: Институт археологии НАН Украины, 83–90.

Sava, E. and Kaiser, E., 2011. Поселение с «зольниками» у села Одая-Мичурин, Республика Молдова: Археологические и естественнонаучные исследования / *Die Siedlung mit „Aschehügeln" beim Dorf Odaia-Miciurin, Republik Moldova: Archäologische und naturwissenschaftliche Untersuchungen*. Bibliotheca «Tyragetia» 19. Chișinău: Muzeul Naţional de Istorie a Moldovei.

Schmidt, H., 1932. *Cucuteni in der oberen Moldau, Rumänien. Die befestigte Siedlung mit bemalter Keramik von der Steinkupferzeit bis in die vollentwickelte Bronzezeit*. Berlin, Leipzig: De Gruyter.

Shmagliy 1980: Шмаглий, Н.М., 1980. Крупные трипольские поселения в междуречье Днепра и Южного Буга. *In*: И.И. Артеменко, ed. Первобытная археология – поиски и находки. Киев: Издательство «Наукова думка», 198–203.

Shmagliy and Videiko 1990: Шмаглий, Н.М. and Видейко, М.Ю., 1990. Микрохронология поселения Майданецкое. *In*: В.Г. Збенович *et al.*, eds. Раннеземледельческие поселения-гиганты трипольской культуры на Украине. Тез. докл. 1-го полевого семинара. Тальянки, Веселый Кут, Майданецкое: Институт археологии НАН Украины, 91–94.

Shmagliy and Videiko 2001-2002: Шмаглий, Н.М. and Видейко, М.Ю., 2001-2002. Майданецкое – трипольский протогород. *Stratum Plus*, 2001-2002 (2), 44–140.

Țerna, S., 2016. Geomagnetic surveys of the Neolithic and the Copper Age sites from the Republic of Moldova (1968-2016): main results, current state and future perspectives. *Raport*, 11, 187–225. Available from: https://raport.nid.pl/wp-content/uploads/2020/03/Terna-2016.pdf

Țerna, S., Rassmann, K., Vasilache, M. and Radloff, K., 2016. Stolniceni I – new research on a Cucuteni-Tripolye large site. *In*: A. Zanoci, E. Kaiser, M. Kashuba, Izbitser, E. and M. Băţ, eds. *Mensch, Kultur und Gesellschaft von der Kupferzeit bis zur frühen Eisenzeit im nördlichen Eurasien. Beiträge zu Ehren zum 60. Geburtstag von Eugen Sava* / *Man, Culture, and Society from the Copper Age until the Early Iron Age in Northern Eurasia. Contributions in Honour of the 60th Anniversary of Eugen Sava*. Tyragetia International 1. Chişinău: Bons Offices, 41–52.

Țerna *et al.* 2017: Церна, С.В., Рассманн, К. and Рудь, В.С., 2017. Гончарный горн с позднетрипольского поселения Столничень I (Единецкий район, Республика Молдова) и производство керамики к востоку от Карпат в IV тысячелетии до н. э. / A Pottery Firing Kiln from the Copper Age Settlement Stolniceni I (Edineţ District, Republic of Moldova) and the Production of Pottery to the East from the Carpathians in IV Millennium BC. *Stratum Plus*, 2017 (2), 301–330.

Țerna, S., Vornicu-Țerna, A., Hofmann, R., Dal Corso, M., Shatilo, L., Vasilache-Curoşu, M., Rud, V., Knapp, H., Kirleis, W., Rassmann, K. and Müller, J., 2019. Stolniceni – Excavation results from the 2017 campaign. *Journal of Neolithic Archaeology*, 21, 209–282. Available from: DOI:10.12766/jna.2019.9

Țerna, S., Vornicu-Țerna, A. and Rassmann, K., 2018. New data on the formation of complex sites in the Western area of the Cucuteni-Tripolye culture. *In*: И.В. Бруяко, Л.В. Носова and Л.Ю. Полищук, eds. Народи і культури нижнього дунаю в давнину. Матеріали Міжнародної науково-практичної конференції (м. Ізмаїл, 23-26 серпня 2018 р.). Ізмаїл: Одеський Археологічний Музей НАН України, Міністерство Освіти і Науки України Ізмаїльський Державний Гуманітарний Університет, 15–25.

Uhl, R.A., Vasilache-Curoşu, M., Sîrbu, M., Sîrbu, L., Bicbaev, V., Steiniger, D., Zidarov, P., Sava, E. and Hansen, S., 2014. Petreni in der nödlichen Moldaurepublik. Bericht über die Ausgrabung der Jahre 2011–2013. *Eurasia Antiqua*, 20, 185–205.

Ursu, C.-E. and Țerna, S., 2015. Tracing the megastructures back in time: an exceptional building from the settlement Baia-În Muchie, Suceava county, Romania. *In*: М.Ю. Відейко, Д. Чапман, І.А. Козир and В.В. Собчук, eds. На східній межі старої Європи. / *At the Eastern frontiers of Old Europe.* Матеріали міжнародної наукової конференції, Кіровоград, Небелівка, 12–14 травня 2015 року. Кіровоград: Кіровоградська обласна державна адміністрація и друг, 12–14.

Videiko and Burdo 2004: Відейко, М.Ю. and Бурдо, Н.Б., eds., 2004. Енциклопедія Трипільської Цивілізації, Vol. 1-2. Київ: Укрполіграфмедіа. Available from: https://archive.org/details/trypillia

Videiko, M. and Chapman, J., 2020. Ditches. *In*: B. Gaydarska, ed. *Early urbanism in Europe. The Trypillia megasites of the Ukrainian forest-steppe*. Warsaw, Berlin: De Gruyter, 233–236. Available from: DOI:10.1515/9783110664959-008

Videiko, M. and Rassmann, K., 2016. Research on Different Scales: 120 Years of Trypillian Large Sites Research. *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE.* Themes in Contemporary Archaeology 2. London, New York: Routledge, 17–28. Available from: DOI:10.4324/9781315630731

Vinogradova 1972: Виноградова, Н.М., 1972. Памятники переходного этапа Триполья BI–BII в Поднестровье. Советская археология, 1972 (1), 36–56.

Vinogradova 1973: Виноградова, Н.М., 1973. Памятники переходного этапа Триполья BI–BII в Побужье и Поднепровье. Краткие сообщения Института археологии, 134, 20–27.

Zagny *et al.* 1971: Загний, Г.Ф., Круц, В.А. and Русаков, О.М., 1971. Опыт применения протонного магнитометра в археологии. Советская Археология, 1971 (3), 203–207.

Zbenovič, V.G., 1996. *Siedlungen der frühen Tripol'e-Kultur zwischen Dnestr und Südlichem Bug*. Archäologie in Eurasien 1. Espelkamp: Leidorf.

CONCLUSION

21. Transformations of Trypillia settlements

Johannes Müller, Robert Hofmann, Wiebke Kirleis, Liudmyla Shatilo, Frank Schlütz, Marta Dal Corso, Stefan Dreibrodt, Mykhailo Videiko, Vitalii Rud, Stanislav Țerna†, Andreea Țerna

Introduction

Research on the so-called Trypillia or Tripolye phenomenon has been performed almost continuously since the end of the 19th century (Videiko and Rassmann 2016; Videiko and Burdo 2004). Analysis of aerial images and the subsequent application of large-scale magnetic surveys in the 1970s and 1980s stimulated new intensive and innovative research which was triggered by the key finding that some Trypillia settlements – in particular of the Bug-Dnieper interfluve – possibly represented the by far largest population agglomerations in prehistoric Europe in terms of their sheer settlement size of up to 320 ha, their exceptional spatial layout, and their huge number of houses (Shishkin 1985). This insight raised an intensive discussion around questions such as which dynamic led to the emergence and the abandonment of such settlements, how these unique sites should be interpreted, and how the assumed high population could have been managed.

Given to the methodological limitations that were obvious due to the few possibilities for secure scientific dating and reliance on mainly typological descriptions and analyses, the interpretation of the sites remained hypothetical. Nevertheless, at the beginning of the 1990s some basic hypotheses had been put forward, which encompassed various aspects such as the intra-site chronology and the duration of a (mega-)site (Ryzhov 1990), the typological grouping of settlements and their relative chronology, settlement layout, social structure, factors contributing to the emergence and disappearance of these large settlements (Zbenovič 1990; Kruts 1989; Kruts 1990; Movsha 1984; Shmagliy and Videiko 1990; Shmagliy and Videiko 2001–2002; Tsvek 1989). Since then, during the last 30 years an immense

methodological development took place in archaeology, with respect to scientific dating including Bayesian approaches, geophysical surveys, the application of stable isotope and aDNA research, new sedimentological methods and new structural and post-structural approaches to the interpretation of prehistoric societal practices. These methodological innovations (cf. Kristiansen 2022) changed the possibilities and interpretations of prehistoric research and projects all over the world, but with a notable impact in Europe. This also influenced immensely the approaches and results in Trypillia research (Chapman *et al.* 2014b).

In respect to Trypillia mega-sites, the huge geomagnetic surveys, initiated by Knut Rassmann together with Mykhailo Videiko, Vladimir Kruts and other colleagues, and also involving Kiel University, changed the dimension and spatial resolution of the discovered archaeological features. With respect to larger excavation projects, the fieldwork in Talianki by Vladimir Kruts and Oleksii Korvin-Piotrovsky (Menotti and Korvin-Piotrovskiy 2012), in Nebelivka by John Chapman and Mykhailo Videiko (Gaydarska 2020), in Maidanetske by Johannes Müller and Mykhailo Videiko and their teams (Müller *et al.* 2017); but also at Moldovan sites like Stolniceni by Stanislav Țerna, Knut Rassmann and Johannes Müller (Țerna *et al.* 2019b), Trinca by Ghenadie Sîrbu and Johannes Müller and their teams (Müller *et al.* 2023), and Gordenesti by Ghenadie Sîrbu and Małgorzata Rybicka (Rybicka *et al.* 2023) have enabled a much more detailed view on Trypillia developments (cf. Müller *et al.* 2018; Hofmann *et al.* 2018; Gaydarska 2020; Müller *et al.* 2022a; Ohlrau 2020a). The integration of systematic archaeobotanical investigations by the Kiel University team, coupled with a shift of focus from excavating house structures to the digging of pits (Țerna 2021) paved the way for understanding the economic baseline for the mega-site phenomenon (Kirleis *et al.* 2024; Schlütz *et al.* 2023).

As part of a broader publication strategy, the chapters of these two volumes have included outcomes obtained at Kiel University within the CRC 1266 'Scales of Transformation: Human-environmental interaction in prehistoric and archaic societies', in cooperation with the Institute of Archaeology of the National Academy of Science of Ukraine, the Borys Grinchenko Kyiv University, the State Historical and Cultural Reserve 'Trypillia Culture' in Lehedzyne, the High Anthropological School Chișinău, the National Museum of History of Moldova and the Moldova State University Chișinău as regional partners, and the Romano-Germanic Commission of the German Archaeological Institute. Beside the aforementioned fieldwork in Maidanetske, Stolniceni and Trinca, many other investigations also took place since 2016 in the CRC 1266 sub-project D1 'Population Agglomerations at Tripolye-Cucuteni Mega-sites' (cf. Rud *et al.* 2019a; Rud *et al.* 2019b; Hofmann *et al.* 2019b).

Project design and outcomes

The broad regional and chronological spectrum of contributions in the two volumes demonstrates our multi-scalar research approach, which includes the diachronic investigation of transformations at different spatial and chronological scales, and thus allows a more general view of Chalcolithic Trypillia communities between the river basins of the Siret and Prut in the west and the Ros and Dnieper in the east. This approach, upon which the division of the book into regional foci is based, entails:

1. the focus on regional reconstructions in three larger principal test regions (Fig. 1 A–C)
2. the in-depth investigation of selected key sites, which are representative for the specifics of these regions
3. the interregional comparison of the three principal test regions.

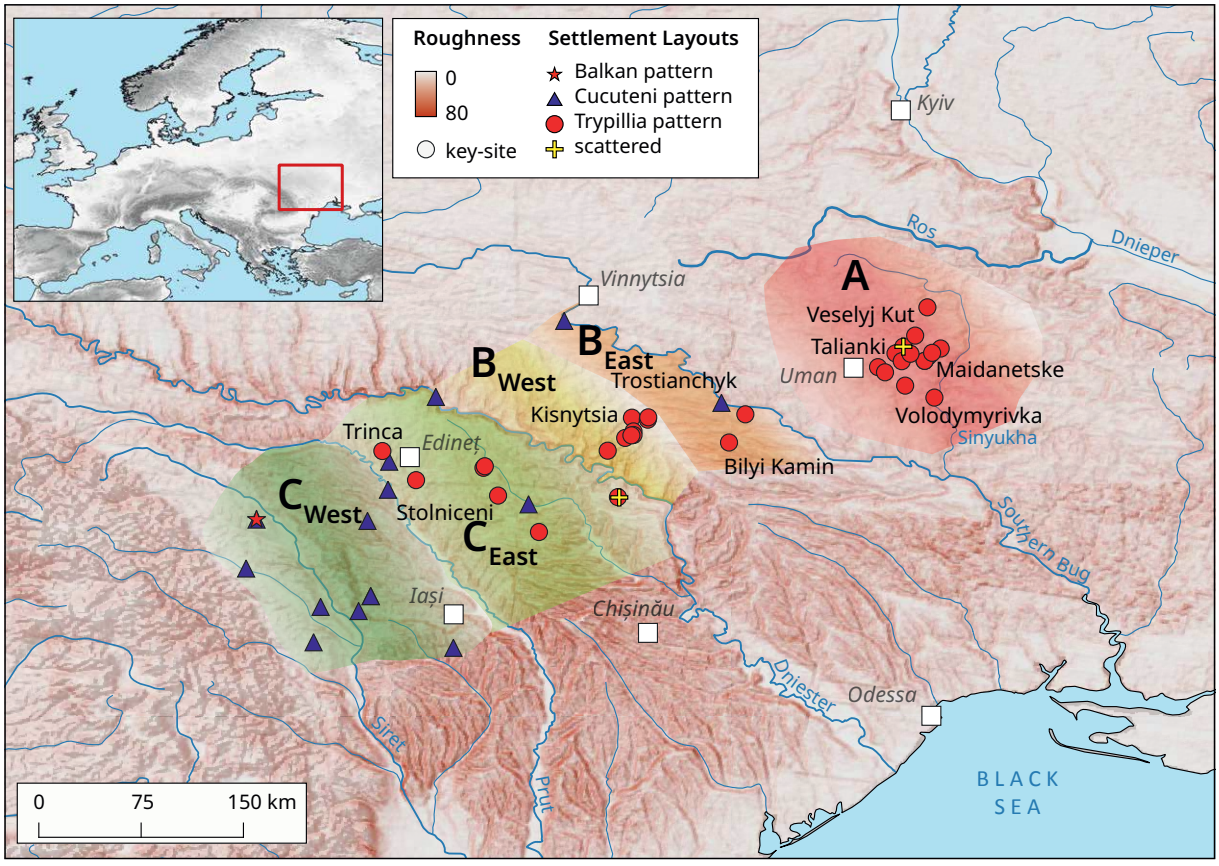


Figure 1. Geographic location of the test regions A–C, including key sites and settlement layouts (see Chapter 20, this work, Vol. II) between the Carpathian foothills and the River Ros. Test regions: A – Sinyukha River Basin (Southern Bug-Dnieper interfluve); B – Dniester-Southern Bug interfluve (Region B West – Dniester and the Southern Bug watershed; Region B East – Southern Bug Basin); C – Siret-Dniester interfluve (Region C West – Siret-Prut interfluve; Region C East – Prut-Dniester interfluve). Graphics: Robert Hofmann/Carsten Reckweg, Kiel.

Such a multi-scalar approach, in which the comparison of regions is based on a common scientific dating strategy, is well-suited to understanding the socio-environmental transformations of Trypillia sites and mega-sites (>100 ha), including the reconstruction of the obviously multiple processes that led to their emergence and decline. The combination of palaeoenvironmental, archaeobotanical, osteological, anthropological, stable isotope and aDNA research, as well as geophysical methods, in addition to material culture and architecture studies, enables differentiation of many aspects of the Trypillia communities.

In terms of methodology, beside a broad interdisciplinary spectrum of analysis, various geophysical methods, including high-resolution archaeomagnetic surveys, play a key role in deciphering the historical processes of Trypillia communities (*e.g.* Chapman *et al.* 2014b; Rassmann *et al.* 2014; Ohlrau 2015; Hofmann *et al.* 2016; Ohlrau and Rud 2019; Hale 2020). High-resolution settlement plans formed the precondition for the applied sampling strategies and advanced transdisciplinary analysis. Key issues are:

- the integrated geophysical and archaeological analysis of the site plans obtained (*e.g.* Pickartz *et al.* 2019; Pickartz *et al.* 2022)
- the exemplary archaeological excavation of different categories of features, acknowledging the relevance of pits to gain an understanding of the economy (Müller *et al.* 2017)

- systematic archaeobotanical sampling of the different habitation components/ archaeological contexts (pits, house floors, kilns, *etc.*; Chapter 7, this work, Vol. I; Kirleis *et al.* 2024)
- focusing on pits as long-term archives with above-average preservation of individual households and communal facilities (Müller and Videiko 2016; Țerna 2021).

The sampling strategies thus constitute the backbone of the applied dating approaches and the targeted sampling of the sites for scientific analyses and further studies of material culture including architecture.

The application of this research strategy led to a number of results on different spatial scales, from the local level to regional aspects to the whole Trypillia distribution area. The basic approach enables a sequential description of economic and societal practices, as well as environmental changes, at different spatial and temporal scales.

Chronology and transformation phases

General chronology

191 newly obtained ^{14}C dates from 50 settlements are analysed in Chapter 19, this work, Vol. II (cf. Ohlrau 2020a; Millard 2020; Harper *et al.* 2021; Țerna *et al.* 2019b; Harper *et al.* 2023). They contribute to a much better understanding of the chronology of Trypillia settlement processes and the reconstruction of transformation phases.

The emergence of large aggregated settlements with characteristic ring-shaped layouts thus represents a process that began in connection with the appearance of Trypillia B1–B2 pottery styles and spread from west to east with a temporal gradient of about 150 years. Aggregated settlements of this ring-shaped configuration, which were initially associated with modest to medium-sized settlements, first appeared from ca. 4300 BCE in the region between Prut and the Southern Bug, and spread from there to the region east of the Southern Bug by 4130 BCE. Stylistically, Trypillia B2 and C1 pottery styles mark the peak phase of Trypillia population aggregation, which began in the west (Fig. 1, test region C) around 4050 BCE and in the east (test region A) from 3950 BCE. In the wider catchment area of the Southern Bug, we observe the formation and development of mega-sites with sizes of >100 ha during this phase, some of which were maintained until 3600 BCE at the latest. The disintegration of these unique settlements was largely completed by this time.

Based on the results obtained, we can again verify the known three main periods of Trypillia development (cf. Menotti and Korvin-Piotrovskiy 2012; Müller *et al.* 2016c; Ohlrau 2020a; Shatilo 2021, 235–236):

- Period 1 (Early Trypillia), between 4800 and 4300/4100 BCE, preceding the great population aggregations and characterised by the gradual occupation of the forest-steppe zone between Prut and Dnieper. During this period, we are primarily dealing with small settlements, many of which are located on naturally protected positions in the west.
- Period 2 (Middle Trypillia), between 4300/4100 BCE and 3650/3600 BCE, is characterised in practically all test regions by the accelerated long-distance occupation and increasing concentration of population in initially medium-sized, and later larger and larger, settlements and mega-sites.
- Period 3 (Late Trypillia) followed after the disintegration of aggregated settlements, which begins around 3600 BCE, and is characterised again by dispersed settlement patterns. A process of regionally differentiated disintegration already began earlier, at the latest after 3800 BCE.

Beside these major Trypillia transformations, further detailed transformative developments have been detected on the different spatial and temporal levels.

Chronologies of individual settlements

Alongside the clarification of the general chronology of the Trypillia network, new radiometric dating has led to considerable progress in the clarification of local chronologies of key sites. These dates are based on larger data series for some sites, and show a largely simultaneous existence of many large settlements and mega-sites between ca. 4000/3900 and 3700 BCE (see Chapter 19, this work, Vol. II).

Our dating results show a significantly longer duration of large mega-sites than previously expected. Assuming that soils in the vicinity of mega-sites would deplete quickly, the duration of individual settlements had been estimated to be extremely short, in the range of about 50 years. Correspondingly, sequences of largely non-simultaneously occupied settlements were reconstructed within regions.

Our reconstruction of significantly longer durations in the range of 150 years or even more has considerable consequences for the interpretation of Trypillia societies, insofar as it implies the synchronous occupation of several large settlements and thus significantly higher regional population densities. This is particularly evident for the Sinyukha River Basin (Southern Bug-Dnieper interfluve, test region A), which has the best state of research.

Plans of large settlements reveal different building densities, which generally correlate with the duration of the settlement: while Maidanetske, for example, was settled quite long-term and even the inner part was densely populated, Nebelivka was abandoned quite early in spite of an overall concept suited for a huge occupation.

The detailed analysis of settlement plans and targeted sampling for dating provide new insights into the internal development of several mega-sites: the occupation of mega-sites started with the general layout of the planned occupation. This occupation usually first appeared in association with an outer enclosure and/or the ring-street, which was also in the outer area of the sites. Habitation zones, especially towards the inner part of the settlements, were occupied later (see Chapters 19–20, this work, Vol. II).

Infrastructure facilities such as ditches and pottery kilns are often among the earliest features constructed – obviously a pre-condition for the following occupation process.

During the occupation of mega-sites, two tendencies are visible: on the one hand, a general occupational trend from the ring-corridor to the inner or outer part of the settlement, on the other hand, the infilling of gaps in the house rows and clusters over time. New houses might have been built next to already abandoned ones and burnt ones (Shatilo 2021, 125). The absence of overlapping buildings seems to indicate that once abandoned house plots were not built upon again.

Spatial and demographic differences were detected between mega-sites, including the de-population of certain areas of the sites at the end of each settlement (see Chapter 19, this work, Vol. II; Müller *et al.* 2022b). Differences have been detected between:

- mega-sites that had been occupied until a high density of populated space was reached (Maidanetske)
- mega-sites with a continuous fluctuation of habitation activities over a longer period (Talianki)
- mega-sites which had been abandoned quite early and display a relatively small number of houses (Nebelivka).

In consequence – beside the general trends that could be identified by the dating programme – in comparing Trypillia sites and mega-sites, the reconstruction of site biographies with their different phases is necessary and became possible with our approach.

Research at the local level

Field studies of *individual settlements* in all regions included detailed work at selected key sites, but also small-scale investigations at additional sites. In both cases, magnetic surveys formed the basis for the archaeological fieldwork strategy. Based on the magnetic plans and a context sampling strategy, on the one hand archaeological features were systematically and completely excavated, on the other hand test trenches were excavated to aid in the reconstruction of the overall site process by obtaining samples for absolute dating, as well as economic and material culture analyses (see Chapters 11–15, 17 and 18, this work, Vols. I–II).

Strategically, magnetic surveys and subsequent small-scale excavations took place at sites dating from early or pre-mega-site times (test regions A: Southern Bug-Dnieper interfluve and B: Dniester-Southern Bug interfluve) to post-mega-site times (regions C: Siret-Dniester interfluve, B, and partly A). In addition, small settlements in the vicinity of the Maidanetske mega-site were investigated in the same manner (Ohlrau and Rud 2019; Chapters 12 and 13, this work, Vol. I). The chosen strategy enabled temporal and spatial expansion of the results obtained thus far in more intensively researched key sites, thus contributing significantly to a regional view on the dynamics of Trypillia settlement patterns (Chapter 20, this work, Vol. II).[1]

A more intensive research took place at key sites. For the Sinyukha River Basin (test region A) the first results from the key settlement Maidanetske were presented by Müller *et al.* (2017). In the Dniester-Southern Bug interfluve (test region B), a similar key settlement was Bilyi Kamin (Rud *et al.* 2019a; Rud *et al.* 2019c); and in the Siret-Dniester interfluve (test region C) first Stolniceni 1 (Țerna *et al.* 2019b; Chapter 16, this work, Vol. II) and, starting in 2022, Trinca (Müller *et al.* 2023). Each of these sites provided extraordinary materials for a renewed understanding of the Trypillia phenomenon.

Bilyi Kamin represents one of the few proper mega-sites in the Dniester-Southern Bug interfluve (test region B) that reached about 100 ha in size. The site was occupied between 3950 and 3750 BCE with the highest dating probability in the 39th century BCE. Consequently, the settlement turned out to be abandoned earlier than most mega-sites in the Sinyukha River Basin (Southern Bug-Dnieper interfluve, test region A; Rud *et al.* 2019a, 55–56). As a consequence, both this and the scarcity of later sites in this region imply a population decrease as early as from 3800 or 3750 BCE, and the possibility of an interregional population movement into the Sinyukha region. Bilyi Kamin is remarkable for its three very large mega-structures of more than 60 m in length, which were located on the highest point of the settlement and visible from afar, giving them a clear monumental character.

In **Stolniceni 1** (Siret-Dniester interfluve; test region C), extensive investigations were carried out in a ring-shaped Trypillia settlement that, by reaching a size of 33 ha, ranks among the largest in the region (Țerna *et al.* 2019b). In addition to other infrastructure elements, the so-called 'meeting places' outside of the site were so far only found west of the Dniester River. The site dates back to the 39th

1 However, it should be recognised that limited dating of one site – for example, only one context from a settlement – does not give a complete idea of its chronology and does not reveal the full specificity of the site. As such, a number of questions remain open, in particular the intra-site chronology of smaller settlements, as well as their economy.

and 38th centuries BCE. In addition to the numerous results from the site study, it is important to note the innovative methodological approach associated with the systematic integration of magnetically proven house categories with the study of the pit inventories (Chapter 16, this work, Vol. II).

In contrast to Bilyi Kamin, Stolniceni 1, and many other sites of this time, the 25-ha settlement **Trinca-*La* Șanț** (Siret-Dniester interfluve; test region C) is located on a high limestone plateau or *toltr*. Such a location is more typical for late Trypillia (C2 stage) sites of the Prut-Dniester interfluve dating after 3600 BCE (*e.g.* Markevich 1981; Chapter 17, this work, Vol. II). In addition to the distinctive location of Trinca, which according to today's data dates back to the 39th and 38th century BCE, has an interesting linear and semi-circular arrangement of houses around empty spaces. The newly available data reflect an intensified occupation after the first layout of the outer fortification (Müller *et al.* 2023).

In the Sinyukha River Basin (Southern Bug-Dnieper interfluve; test region A), the key site of research was **Maidanetske**, which – at 200 hectares in size with ca. 3,000 houses and a lifespan of about 300 years – is one of the largest and longest-occupied mega-sites in the area between the Southern Bug and Ros. This settlement is part of a spatial concentration of large mega-sites that, according to recent models, were founded at approximately the same time around 3950 BCE and had different temporal foci for occupation until ca. 3600 BCE.

Building on many years of research by our Ukrainian partners, and based on a high-resolution settlement plan achieved in cooperation with the Romano-Germanic Commission of the German Archaeological Institute, three major excavation campaigns were carried out in Maidanetske in 2013, 2014 and 2016, which made a significant contribution to deciphering the site. The results of these interdisciplinary studies are presented in numerous articles both in previous works (Müller and Videiko 2016; Müller *et al.* 2017; Hofmann *et al.* 2019b; Ohlrau 2020a) and within this work (Chapters 2–10, Vol. I).

It is worth emphasising some methodological achievements from tests at Maidanetske: a detailed decoding of the magnetic plan shows both systematic differences between the architecture of residential houses, as well as between residential houses and communal buildings (Pickartz *et al.* 2019). The masses of burnt daub, which were calibrated based on excavation results, provide important arguments for a socio-topographical differentiation of the settlement, as it is possible to distinguish between more elaborately built houses of founder families along the ring-corridor and the central plaza and houses of later families, built with less effort in other zones of the settlement (Pickartz *et al.* 2022). In a geoarchaeological study, geochemical signatures make it possible to distinguish between more habitation-focused activities mirrored in the built space and more agricultural activities in the ring-corridor and the unbuilt centre of the settlement with higher phosphate values, either due to manuring of gardens or pastoral activities (Chapter 5, this work, Vol. I). Two experimental studies on burnt daub provide important new insights into processing technology, resource use and the burning of houses at the end of their use-life (Chapters 4 and 8, this work, Vol. I). Especially significant is the much lower estimate of the temperature of house burning in contrast to previous models (usually less than 700°C) and the even lower burning temperature of the excavated mega-structure. Clearly, the architecture of the mega-structures was less robust (thus with less daub involved) than the common habitation architecture of domestic houses.

Archaeobotanical investigations on plant macro-remains prove a household-based subsistence economy and suggest that rain-fed agriculture in nutrient-rich soil with a good hydrologic regime sustained the Trypillia population at Maidanetske (Chapter 7, this work, Vol. I). A restricted crop assemblage of hulled wheats (emmer with a tiny admixture of einkorn) and pea constitute the vegetal diet. The cereal by-products indicate the specialised use of chaff as temper for wattle and daub

structures, as well as for animal fodder. Regular occurrence of feather grass indicates the open areas of the forest steppe environment.

Animal bone analyses yielded important insights into both the economic organisation and the ritual significance of animals and animal processing at Maidanetske (Chapter 9, this work, Vol. I). They also helped to clarify various taphonomic issues. The lowest find density and lowest weight of animal bones is known from occupational layers, the highest find density and weight from pits, while mega-structures and domestic houses are in-between. The animal assemblage is dominated by cattle, followed in much smaller quantities by sheep/goat and pigs. If the dominance of sheep/goat and pig in the earlier phases is due to certain context associations of the animal bones (*e.g.* a possible potter's house) or mirror the phase in which the landscape is first cleared, must be left for discussion. The Maidanetske terrestrial snail shell record shows a clear indication of open sunny habitats with a predominance of a dry steppe-like environment within the settlements (Chapter 10, this work, Vol. I).

Transformation of Trypillia societies

Aggregation and Dispersal: Comparison of Trypillia regions

Sinyukha River Basin (Southern Bug-Dnieper interfluve; test region A)

The settlements Chizhivka (20 ha, ca. 4050–3990 BCE), Veselyj Kut (60 ha; ca. 4070–4000 BCE) and Volodymyrivka (85 ha; 3920–3800 BCE), discussed in Chapter 11 (this work, Vol. I), exemplify the process of increasing population aggregation in increasingly larger settlements. In the catchment area of the Sinyukha River, this development began after 4100 BCE at the latest with medium-sized settlements, and led after 4000 BCE to the establishment of the largest mega-sites such as Nebelivka, Maidanetske, Dobrovody and Talianki, which were several hundred hectares in size (*e.g.* Ohlrau 2020a). The fact that small settlements were largely absent before and during this phase indicates that these settlements were founded as part of a directed occupation process (Shatilo 2021). In terms of population, the increase in settlement sizes probably implies an increase in populations from around 500 (Chizhivka) and about 2500 (Veselyj Kut) to communities with populations around 5,000 (Volodymyrivka) to about 10,000 (*e.g.* Maidanetske) inhabitants.

The investigations of small settlements (Chapters 12 and 13, this work, Vol. I) consistently show that the majority of this category of settlements date to the late phase of the mega-sites, after 3800 BCE. Consequently, the inhabitants of these settlements probably formed communities that made the conscious decision not to live in those still-existing mega-sites which continued. This shows that the disintegration of Trypillia mega-sites began in the Sinyukha Region around 3800 BCE at the latest. Elsewhere, increasing social inequality (Hofmann *et al.* 2024) and centralisation of decision-making processes (Hofmann *et al.* 2019b) were identified as key factors in this process.

Dniester and the Southern Bug watershed (test region B)

Chapter 14 (this work, Vol. II) deals with the results of intensive settlement research in the region Dniester and the Southern Bug watershed around the modern town

Kryzhopil on the watershed between the Dniester and the Southern Bug, which included magnetic surveys, surface collections and excavations at various sites. In this region, smaller (3–10 ha) to large settlements (Vilshanka 25 ha, Zabolotne 40 ha) of the ring-shaped Trypillia type appear from the 43rd century BCE onwards, and continued to exist until the 41st or 40th century BCE. Settlements of earlier Trypillia phases have not yet been found here. We interpret the enormous size of some settlements and the presence of triple settlements such as Zabolotne-Ternivka-Soniachne (together >47 ha) in the close vicinity as possible early forms of more politically integrated mega-sites within ongoing population aggregation processes. In light of this clear formation of large settlements, the wide-scale collapse of settlements in this region around 3950 BCE at the latest is particularly remarkable. It is reasonable to assume that the population largely moved to other regions.

The region around the modern town of Chechelnyk, located 50 km further south-east and closer to the Southern Bug, was identified as one of the possible target regions for this settlement mobility. Here, several mega-sites appear in the wider surroundings from around 3950 BCE onwards. Bilyi Kamin (100 ha), one of these new mega-sites, was investigated in more detail during several excavation campaigns in collaboration with the Institute of Archaeology of the National Academy of Sciences of Ukraine (Rud *et al.* 2019a; Rud *et al.* 2019c). This settlement with a ring-shaped Trypillia layout probably existed between 3950 and 3750 BCE (68.2%; focus in the 39th century). As exemplified by the case of the Viitivka settlement (50 ha) on the Southern Bug, large settlements continued to exist in this region until the end of the 37th century BCE, following the abandonment of this mega-site around 3690 BCE.

Along with the disintegration and abandonment of large settlements in the Chechelnyk region, we documented a re-occupation of the Kryzhopil area around 3600 BCE. The settlements Kisnytsia (7 ha) and Krynychky-Ferma (14 ha), which are characterised by small to medium sizes and degraded ring-shaped settlement layouts, were investigated more closely (Rud *et al.* 2023). To our knowledge, the occupation of this region ended again in the 35th century BCE.

Siret-Dniester interfluve (test region C)

In contrast to regions A and B, in the Siret-Dniester interfluve we are dealing with relatively moderate degrees of population aggregation. The size of settlements did not significantly exceed 30 ha at any time during the studied period. However, Stanislav Țerna and Andreea Vornicu-Țerna recently highlighted the thus far poorly researched phenomenon of twin and triple settlements, which is associated with Trypillia B2 and C1 pottery styles, and which form settlement agglomerations of up to 60 ha in size (Țerna and Vornicu-Țerna 2021). Although the coexistence of such twin and triple settlements still requires typology-independent proof, similar pottery styles suggest that they may represented simultaneously occupied settlement aggregations. This implies that these settlement groups might be settlement aggregations of another type, for which, however, one would have to assume a lower degree of political integration (compared to mega-sites elsewhere).

Radiometric dating of 26 settlements from Moldova obtained during the last decade indicates that the formation of large settlements such as Stolniceni I, Petreni and Brînzeni VIII took place around and after 4000 BCE (Chapter 19, this work, Vol. II). However, the existence of earlier, similarly large settlements (*e.g.* Badiceni I), associated with Cucuteni A–B/Trypillia B1–B2 pottery styles, has been highlighted. These cases, which have not yet been radiometrically dated, may indicate an earlier onset of larger population aggregations (Țerna and Vornicu-Țerna 2021), although it is still unclear whether these early settlements already show the characteristic ring-shaped layout of other Trypillia settlements.

Alongside large settlements built in the open terrain, such as Stolniceni I and Petreni, small (*e.g.* Mitoc-Pisc) and large settlements (*e.g.* Brînzeni VIII) continued to exist in more sheltered locations during the aggregation phase. A particularly impressive 25-hectare settlement located on a naturally protected rock plateau was recently investigated in Trinca-La Șanț (Chapter 17, this work, Vol. II; Müller *et al.* 2023). Consequently, during the aggregation phase in the Siret-Dniester interfluve (test region C), we observe a considerable diversity of settlements in terms of size and position in the landscape.

Large settlements existed until ca. 3700 BCE according to the data available to date. They were followed by a phase of reorganisation of the settlement system that has not yet been sufficiently investigated. Chapter 18 (this work, Vol. II) presents the results of magnetic and archaeological investigations of Late Trypillia settlements in the micro-region of Cunicea on the right side of the Dniester. Around and after 3500 BCE, medium-sized settlements (*e.g.* Cunicea 3) are still represented here alongside small settlements with a row-like structure (Cunicea I). However, their degraded layout may have been the result of multiple occupations.

Comparision: from the Sinyukha River Basin to the Siret-Dniester interfluve (test regions A–C)

An interregional comparison reveals both certain synchronicities as well as deviating trajectories of population aggregation and dispersal. These are:

- The regionally differentiated onset of population aggregation starting from 4300/4250 BCE in the Dniester-Southern Bug interfluve (test region B) and from 4100 BCE at the earliest in the Sinyukha River Basin (test region A), following a west-east gradient. In the Siret-Dniester interfluve (test region C), the early phase of population aggregation is not yet fully recorded.
- The apparently unconditional establishment of medium to very large settlements without earlier (dispersed) settlements. This suggests that the settlements were established as a result of in-migration. This is in particular evident in the Sinyukha River Basin (test region A), where early small settlements directly before the mega-site phase are completely missing.
- Major differences in the scale of population aggregation between the Sinyukha River Basin (test region A) and the Siret-Dniester interfluve (test region C) by a factor of 10. The Dniester-Southern Bug interfluve region (test region B) is in-between (Fig. 2A).
- Persistence of mega-sites and large settlements.
- A slight dispersal process starting around 3800 BCE in the Sinyukha River Basin (test region A), and slightly earlier in the Dniester-Southern Bug interfluve (test region B) and the Siret-Dniester interfluve (test region C), culminating in all regions with an end of mega-sites and large settlements around 3600 BCE.

Figures 2–3 visualise the socio-environmental spatial and temporal patterns and proxies so far reconstructed, in detail:

A) Spatial differences in settlement sizes indicate highly different degrees of population aggregation between the Sinyukha River Basin (test region A), the Dniester-Southern Bug interfluve region (test region B) and the Siret-Dniester interfluve (test region C). Chronologically, population aggregation already started around 4300 BCE, culminated around 3900 BCE and lasted until 3600 BCE (Chapter 19, this work, Vol. II).

B) In the Sinyukha River Basin (test region A), the Dniester-Southern Bug interfluve region (test region B) and the Prut-Dniester interfluve region (test region C, east), similar uni- and bimodal and ring-shaped settlement layouts existed. To the west of

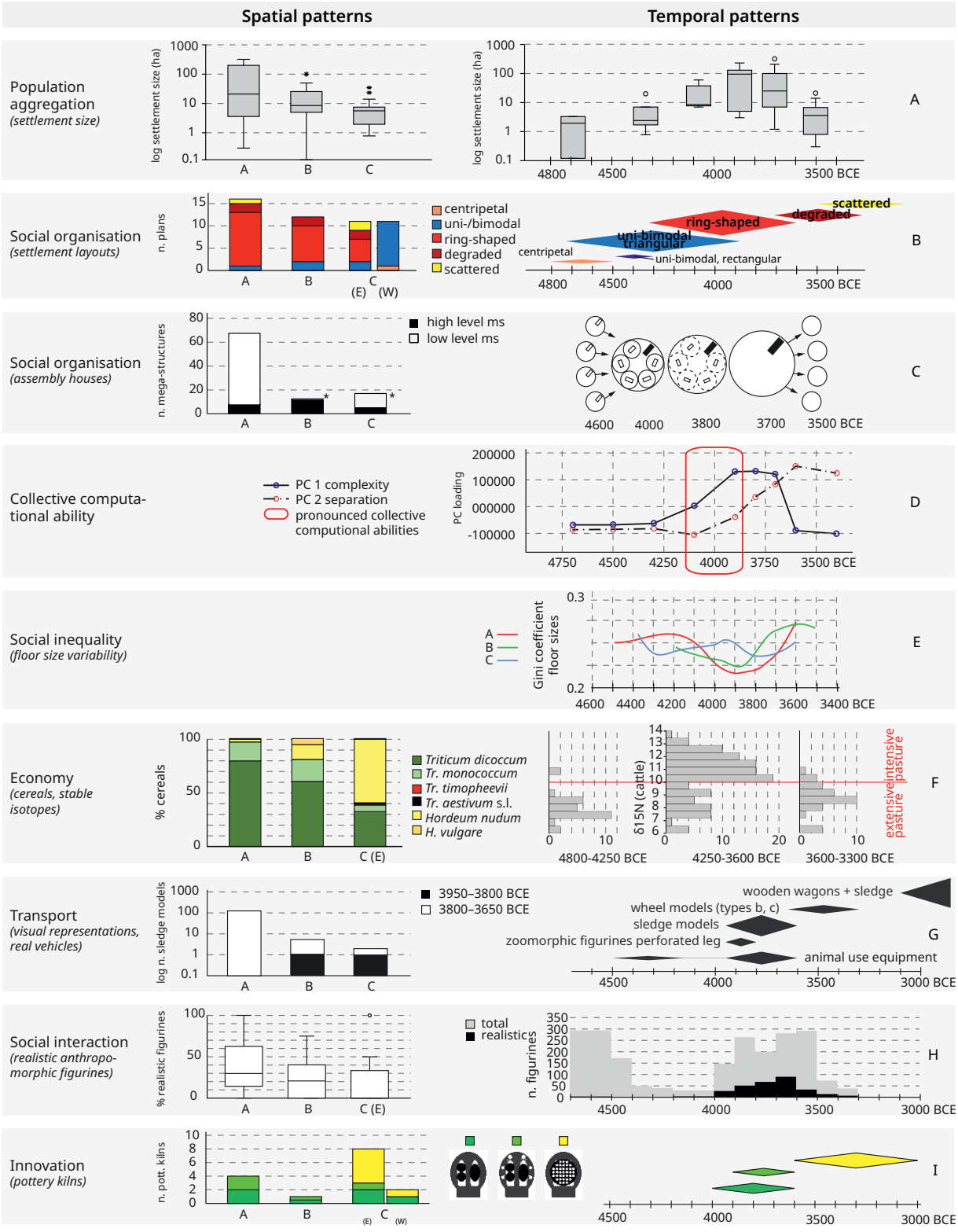


Figure 2. Spatial and temporal patterns of selected parameters and proxies in the study regions A–C (explanation see text).

the Prut (Siret-Prut interfluve; test region C, west), ring-shaped layouts are absent so far. Chronologically, we observe the emergence of well-planned ring-shaped layouts associated with the formation of aggregated Trypillia settlements starting from ca. 4300 BCE. Linked to the disintegration of aggregated Trypillia communities, degraded layouts occur in which the ring-shaped structure is only rudimentarily present and which are less well-planned (Chapter 20, this work, Vol. II).

C) Integrative communal houses (mega-structures) are interpreted as an indicator for a bottom-up social organisation of Cucuteni-Trypillia communities. Resulting from the fusion of smaller communities into large aggregated Trypillia communities, a system of low- and high-level communal houses for sequential, bottom-up decision-making processes was established around 4000 BCE concentrated in the Sinyukha River Basin (test region A). From around 3800 BCE, an increasing loss of importance of low-level communal houses indicates increasing centralisation of decision-making processes, which contributed to the disintegration of aggregated settlements (Hofmann *et al.* 2019b).

D) Principal Component *eigenvalues* of the individual phases show a substantial increase in complexity from about 4200 BCE onward, peaking around 3900 BCE and reaching a certain plateau before an abrupt collapse by 3700 BCE. The high intrinsic load of the variables ring-corridor, mega-structures, and pottery styles shows that, especially from ca. 4100–3800 BCE, the 'collective computational ability' of early mega-site communities can be described. The increase of component 2 ('separation') indicates increasing internal tension, which led to the collapse of mega-sites (Müller *et al.* 2022a).

E) Gini coefficients calculated based on the variability of house floor sizes provide a proxy for the development of social inequality in Trypillia settlements between 4500 and 3500 BCE (Hofmann *et al.* 2024). The decrease in the house floor size variability, associated with the formation of aggregated Trypillia settlements, indicates an egalitarian ideology and effective mechanisms to reduce social inequality in the Sinyukha River Basin (test region A) and the Dniester-Southern Bug interfluve (test region B). Along with the increasing centralisation of decision-making processes, social inequality increased again from around 3800 BCE onwards.

F) Spatial differences in the diversity and abundance of crops are probably the result of Trypillia settlement processes and adaptations to specific environmental conditions (Kirleis *et al.* 2024). Nitrogen stable isotope values from cattle exemplify the establishment of a *mega-site economy* based on the cultivation of cereals and legumes, as well as manuring and intensive livestock farming, in the Sinyukha River Basin (region A) and the Dniester-Southern Bug interfluve region (B) associated with aggregated Trypillia settlements (Schlütz *et al.* 2023).

G) Indications of land transportation devices are present in all regions ca. 3950–3650 BCE, visible, for example, in the chronological distribution of sledge models (Fig. 2F, left; Shatilo 2021). The aoristic distribution of various archaeological archives describes the development of land transport devices between 4500 and 3000 BCE, as mirrored in the archaeological record. The early appearance of sledge models and the later presence of waggons suggest independent innovation contexts (Shatilo in prep.).

H) Social interactions change according to the analysis of anthropomorphic representations. While the distribution of anthropomorphic figurines with realistic elements increases from west to east, their chronological distribution in particular

indicates an increase in realistic depictions during the mega-site phase (after Shatilo and Hofmann 2021; Shatilo and Hofmann 2024).

I) Associated with the shift to the production of oxidation-fired painted pottery in aggregated Trypillia communities, different models of a new type of freestanding updraft pottery kiln were invented around 4000 BCE, in which a compartmentalised firebox and a firing chamber for the pottery were arranged one above the other, allowing an overall better control over the firing temperature (Țerna *et al.* 2019a).

Beside these economic, social and cultural shifts, the changing environment could in particular also be indicated, partly as a result of the Trypillia occupation (Fig. 3). The forest-steppe environment was transformed by the expansion of open steppe elements as effect of population agglomeration. The macrobotanical record of charred *Stipa* (feather grass) awns from the Cucuteni-Trypillia sites, percentages of which can be used as proxy evidence for steppe expansion, show a steady increase of *Stipa* percentages from the earliest to the latest Trypillia stage, C2 (Kirleis *et al.* 2024). Further, the cultivation methods of the Trypillia farmers stimulated the formation of dark steppe soil by encouraging the digging and casting activity of anecic earthworms at Maidanetske and began the formation of the modern cultivated steppe landscape (Dreibrodt *et al.* 2020; Dreibrodt *et al.* 2022).

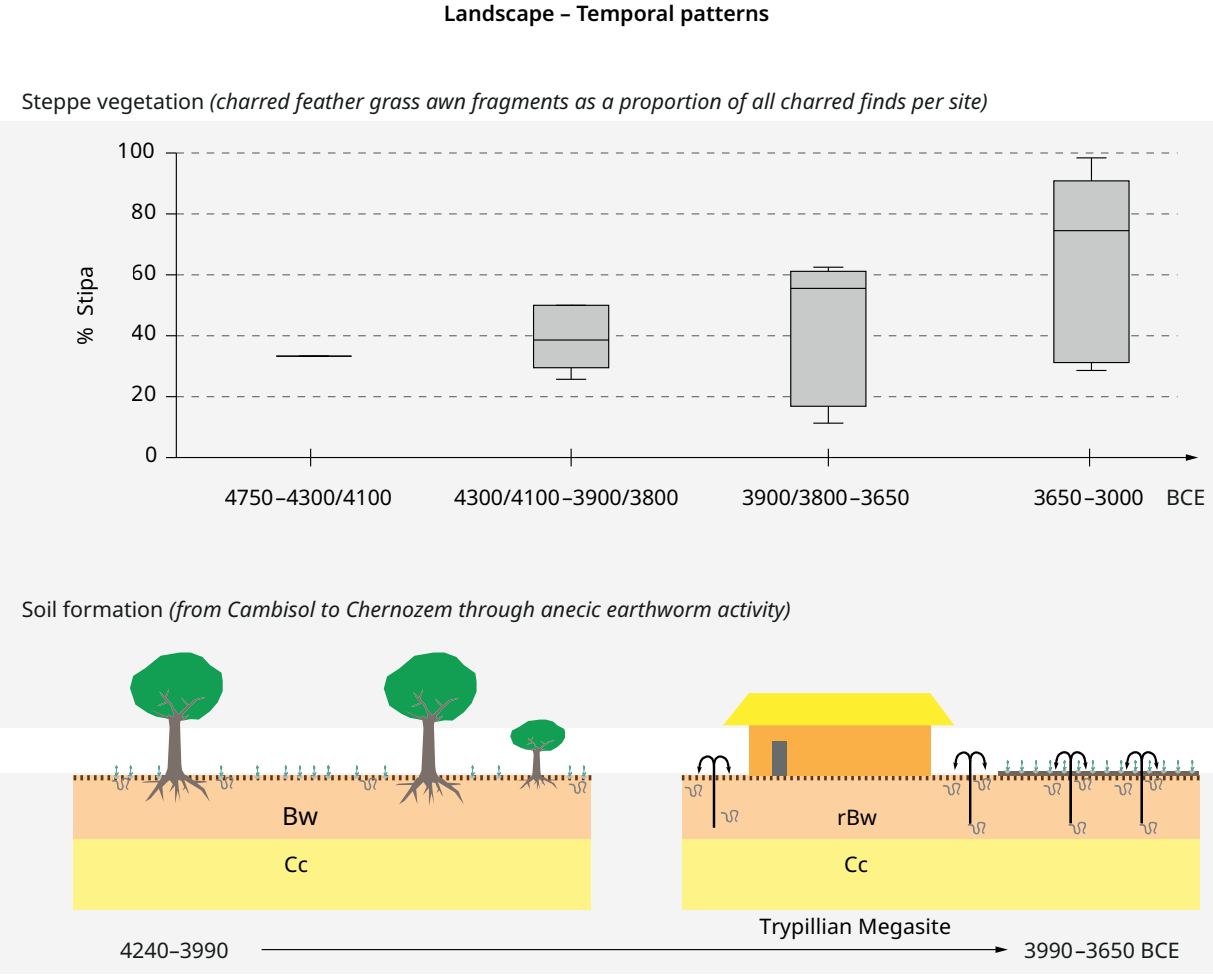


Figure 3. Temporal patterns of selected parameters and proxies in the study regions A–C for landscape transformation (graphics: Wiebke Kirleis/Carsten Reckweg, Kiel).

Economy of Trypillia societies

Studies carried out at local and supra-regional scales increasingly allow a spatial and functional differentiation of the economic basis and subsistence in Trypillia communities. This is possible through systematic comparisons of different context categories and different spatial units, within key settlements and at the macroscale. Archaeobotanical analyses for Maidanetske and other key sites (*e.g.* Stolniceni) focused on the investigation of pits and make a significant contribution to overcoming limitations caused by the frequently poor preservation of botanical macro-remains in Trypillia settlements when only near-surface structures like house floors are excavated (Chapter 7, this work, Vol. I).

The population of the Maidanetske mega-site was sustained by a household-focused subsistence economy based on rain-fed cultivation of emmer and pea in nutrient-rich soil with a good hydrologic regime. Although there is evidence of collective activities associated with the processing and consumption of cereals in communal mega-structures, in the form of numerous fragments of grinding stones and charred botanical macro-remains (*e.g.* Hofmann *et al.* 2019a; Chapter 2, this work, Vol. II), there is no clear evidence of communal storage.

Next to dietary purposes, plant resources were used for house construction and served as animal fodder. The analyses of charcoal and daub imprints indicate wood selection, with ash as the prevalent tree in use and most probably a dominant species in the hardwood forest covering the slopes along the rivers in the direct vicinity of the Trypillia sites. As exemplified at Maidanetske, the inhabitants would not have suffered from a significant shortage of wood resources at any time according to different scenarios, with the exception of the phase of maximum house construction and population within a scenario of drier climatic conditions (Dal Corso *et al.* 2019).

The selection of specific harvest residues (chaff) for the organic tempering of daub by Trypillia people and as animal fodder indicates a scheduled social interaction of the farmers after the annual cereal harvest was finished (Dal Corso *et al.* 2018). A calculation of the total amount of harvest residues needed to construct the recorded number of houses in the mega-site of Maidanetske implies that this need was met by the yearly harvest of the fields supporting the inhabitants with nutrition, and there was sufficient chaff left to be used as animal fodder (Chapter 7, this work, Vol. I).

The inventories of fully investigated houses within Trypillia mega-sites show that households were involved to varying degrees in non-subsistence economic activities in addition to food preparation (Ohlrau 2020a, 38–58). Different quantities of grinding stones, loom weights, tokens and imported ceramics indicate different activity foci of households and different degrees of integration in inter-communal exchange (Müller *et al.* 2016b; Ohlrau 2020a; Chernovol 2023; Chapter 16, this work, Vol. II). High-quality pottery with standardised fabrics and advanced pottery kilns, the operation of which required specialist knowledge, indicate possible specialisation in the field of ceramic production and distribution (*e.g.* Korvin-Piotrovskiy *et al.* 2016a; Țerna *et al.* 2019a).

Archaeozoological studies of animal bone assemblages from the mega-site Maidanetske show animal husbandry strategies in which a focus on cattle husbandry was the norm, while sheep, pigs and even more so goats, were of less importance (Makarewicz *et al.* 2022; Chapter 9, this work, Vol. I). Hunting played only a minor role. As the sheep-dominated animal bone assemblage from the context of a pottery workshop shows, there was considerable variability in animal husbandry strategies within the Maidanetske settlement beyond this general trend. This variability is probably one result of specialisations developing in mega-sites. Butchering age distributions indicate that the focus of animal husbandry was on the exploitation of meat, but that the exploitation of dairy products may also have played a certain role.

Analysis of stable isotopes ($\delta^{13}C$, $\delta^{15}N$) of plants, animals, humans and soils shows the establishment of an agricultural system based on keeping of a part of the domestic

livestock fenced-in on intensive pastures to collect manure for the cultivation of pulses (Makarewicz *et al.* 2022; Schlütz *et al.* 2023; Kirleis *et al.* 2024). This so-called mega-site economy can be traced from around 4250 BCE in the Dniester-Southern Bug interfluve (test region B) and from around 4100 BCE in the Sinyukha River Basin (test region A), while in the Siret-Dniester interfluve (test region C) extensive livestock farming was practised exclusively (Fig. 2F). Food-webs reveal that the diet was based to a large extent on the consumption of pulses as the main source of protein and cereals, while meat consumption made up only a relatively small proportion of the diet (Schlütz *et al.* 2023). As a significant proportion of the meat was consumed in the context of ritual feasting activities, meat consumption may have played a central role in sustaining social cohesion and stability within Trypillia communities.

Comparative archaeobotanical studies on a geographical macro-scale show spatial patterns in crop preferences between the test regions A–C, which, however, reflect not only a spatial but also a temporal gradient (*e.g.* decreasing amounts of barley over time; Kirleis *et al.* 2024): while earlier settlements in the Prut-Dniester interfluve (test region C, east) show diverse cereal spectra with high proportions of barley and the wheats emmer and einkorn, later cereal assemblages in the Sinyukha River Basin (test region A) are characterised by the more uniform dominance of emmer, with the rather high-yielding emmer feeding, in particular, the large population in the mega-sites, such as Maidanetske (Fig. 2F). The Dniester-Southern Bug interfluve (test region B), which is represented in the analysed samples by many settlements of the early population aggregation phase before 4000 BCE, is positioned between these two poles. So far, it is unclear whether the observed variability of the crop spectra is due to cultural preferences, the growing conditions of the crops, or sampling bias.

Animal bone assemblages also show different spatial patterns between Cucuteni settlements west of the Prut (test region C, west) and the mega-sites of the Sinyukha area (test region A): compared to eastern mega-sites, western Cucuteni settlements are characterised by longer-term higher proportions of wild animals, the dominance of pigs in some early settlements in north-eastern Romania, and a greater importance of sheep (Orton *et al.* 2020).

Social organisation of Trypillia communities

An important source for the exploration of the socio-economic organisation of Trypillia communities are settlement layouts obtained by magnetic surveys. The formation of aggregated Trypillia settlements from ca. 4300 BCE was closely connected with the development of a new type of concentric configuration of settlements, the key component of which was a circumferential *ring-corridor* or *ring-street*, for which we therefore propose the term 'ring-shaped' settlements (Chapter 20, this work, Vol. II). Possible predecessors of this settlement type emerge in the Pannonian Plain after 5000 BCE (Hofmann *et al.* 2019a). Taking into account the newly-obtained ^{14}C dates, the earliest of such ring-shaped layouts east of the Carpathians are currently known from the Siret-Dniester interfluve (test region C) around 4000 BCE, in the Dniester-Southern Bug interfluve (test region B) around 4250 BCE, and in the Sinyukha River Basin (test region A) around 4150 BCE (Chapter 19, this work, Vol. II; Fig. 2B).

In our view, the ring-shaped configuration of the settlement layout was designed to provide equal access to structural elements and infrastructure of the settlement. Since the layouts of Trypillia settlements show cross-cultural ethnographic analogies to settlement plans of acephalous egalitarian organised communities (*e.g.* Wagner 2019), we assume an egalitarian ideology of the settlement founders. This interpretation is also supported by a diachronic study on the size variability of 7000 houses from 38 settlements (test regions A–C), which serves as a proxy for social inequality (Hofmann *et al.* 2024). Linked to the formation of aggregated ring-

shaped settlements, a decline in vertical social inequality is indicated by decreasing house floor size variability, which only increases again from ca. 3800 BCE associated with the beginning of the disintegration of aggregated settlements (Fig. 2E). In our view, this trajectory indicates that effective mechanisms existed to prevent or lower social inequality.

A further key aspect of our socio-historical interpretation of Trypillia communities is the discovery of multifunctional integrative community houses, so-called mega-structures, which can be identified in magnetic plans at various highly visible positions in the public space (central plaza, secondary plaza, ring-street; Rassmann *et al.* 2014; Ohlrau 2015; Müller *et al.* 2016b; Hofmann *et al.* 2019b). According to the results of excavations of such mega-structures in Nebelivka (Chapman *et al.* 2014a), Dobrovody (Korvin-Piotrovskiy *et al.* 2016b) and Maidanetske (Hofmann *et al.* 2019b; Chapter 2, this work, Vol. I), and also from advanced analyses of magnetic plans (Pickartz *et al.* 2019), these building structures had a specific architecture that differed in construction and internal subdivision from normal dwellings.

Based on different positions within the settlement, in many cases high-level communal houses for the whole settlement (positioned in a central plaza) can be distinguished from low-level communal houses for parts of the community (distributed within the settlement), which in our view are the result of sequential bottom-up decision-making processes and integrative activities at different levels. The establishment of this multi-layered system of institutions resulted from the fusion of originally independent communities into large settlements and mega-sites (cf. Ohlrau 2020b; Ohlrau 2022).

The establishment of the hierarchical system of integrative institutions from ca. 4000 BCE onwards was followed by the increasing loss of importance for low-level institutions and the rise in importance for central institutions from ca. 3800 BCE at the latest (Hofmann *et al.* 2019b; Fig. 2C). We interpret this centralisation process as an indicator for increasing monopolisation of decision-making, which was associated with an increase in social inequality and represents, in our view, a key factor for the disintegration of aggregated Trypillia settlements by dispersion.

The multi-level system of low- and high-level meeting houses became fully developed only in the Sinyukha River Basin (test region A), whereas in settlement plans of the Dniester-Southern Bug interfluve (test region B) and the Siret-Dniester interfluve (test region C) low-level communal houses can be identified only in a couple of isolated cases (Fig. 2C). However, in Stolniceni (Siret-Dniester interfluve; test region C) possible low-level meeting houses were identified, which were not positioned with high visibility in the public space of the settlement, but within rows of houses of the ring-corridor (Chapter 16, this work, Vol. II). In our view, the observed regional differences point to differences in social organisation and might be responsible for the different degrees and durations of population concentrations. In the Dniester-Southern Bug interfluve and the Siret-Dniester interfluve (test regions B and C, respectively), double and triple settlements represent possible settlement agglomerations with presumably lower degrees of political integration (Chapter 14, this work, Vol. II).

Material culture studies

Constant research on individual categories of material culture has become an integral part of our CRC 1266 sub-project 'Population Agglomerations at Tripolye-Cucuteni Mega-sites' throughout its entire duration. The emphasis of the research was aiming to process materials obtained as a result of numerous field work campaigns, and especially studying certain categories of objects and features within separate studies or parts of individual thematic works.

Pottery

Ceramic studies have been mainly focused on, firstly, typological developments for the compilation of typo-chronologies, which are proven by scientific dating (Ohlrau 2020a; Shatilo 2021); secondly, on ceramic production technics, in particular pottery kilns (Korvin-Piotrovskiy *et al.* 2016a; Țerna *et al.* 2019a); thirdly, on finds spectra for the functional interpretation of archaeological features (Ohlrau 2020a; Hofmann *et al.* 2019b; Chapters 2, 4, 11, 12, 13 and 18, this work, Vols. I–II), and fourthly, on the general characterisation of pottery assemblages in order to obtain clues on vessel functions and use (Shatilo 2021, 190–197). Among the array of results obtained, several should be highlighted:

Pottery is traditionally used in Trypillia studies as a key source for the construction of both typo-chronologies and so-called local groups (Shatilo 2021). The basic sequence was elaborated in the first half of the 20th century by Tatiana Passek (1949), and modified subsequently in several steps (Vinogradova 1972; Vinogradova 1973; Movsha 1984).

Since the 1980s, attempts have been made to use statistical methods to establish site-internal chronologies (Ryzhov 1999; Ryzhov 2007; Dergachev 1980). This project's research has shown that while the basic sequence of changes in ceramic styles is not particularly objectionable, the more detailed constructions of the last 40 years require some clarification and/or explanation, especially as typologies could now be proven or disproven by chronologically-relevant radiometric dates.

The question regarding the micro typology of *ceramic styles* does not seem as clear today as before. Ryzhov's (2012a; 2012b) model for the Sinyukha region, for example, assumed 1) a sequential change of one ceramic style (calling it 'local group') to another ('Vladimirovka-Nebelevka-Tomashovka-Kosenovka'), 2) the associated 'short' chronology of these groups, and 3) individual sites (approx. 50 years). ^{14}C dates today show a longer duration for individual sites and their partial synchronicity, even with the greatest restrictions in date modelling (Müller *et al.* 2016a; Rud *et al.* 2019a; Millard 2020; Ohlrau 2020a; Shatilo 2021; Chapter 19, this work, Vol. II). Analysis of the available ceramic complexes shows 1) the absence of a gradual development of one 'style-local group' into another (in the case of Vladimirovka-Nebelevka-Tomashovka), but rather the coexistence of decorative schemes of these three groups, albeit in changing proportions (Shatilo 2021, 168–171, based on data of Brandtstätter 2017), and 2) more prospects for developing chronology at the level of individual (mega-) sites, based primarily on ceramic morphology, and not on the decoration.

The new radiometric dates seem to indicate a broad synchrony or at least temporal overlap of Trypillia B2 and Trypillia C1 pottery styles in all three study regions (Chapter 19, this work, Vol. II), with the same being the case for Trypillia C1 and Trypillia C1–C2 in the Sinyukha River Basin (test region A; Fuchs *et al.* 2023). Although detailed analyses of the associated pottery assemblages are still pending, this shows that the sequence of pottery styles might require further clarification and elaboration.

An important discovery in the last decade concerns *pottery kilns* of a new type with two superimposed chambers, which seem to be associated in particular with large settlements (Korvin-Piotrovskiy *et al.* 2016a; Țerna *et al.* 2019a; Rud *et al.* 2019b; Fig. 2I). In the Sinyukha River Basin (test region A), the emergence of these kilns coincided with the transition from dark-fired pottery with deepened decoration to oxidation-fired painted pottery (Shatilo 2021). We see little evidence so far for such kilns in magnetic plans from sites before 4000 BCE, nor in small settlements. Since we believe that the operation of these kilns required expert knowledge and we observe increasing quality and standardisation of ceramic fabrics starting from about 4000 BCE we assume an increasing specialisation in pottery production embedded in the process of mega-site formation and development (Korvin-Piotrovskiy *et al.* 2016a). In several settlements, pottery workshops were identified

in magnetic plans and excavations provided valuable new insights into the organisation of production and production spectra (Ohlrau 2020a, 71–86; Korvin-Piotrovskiy and Ovchinnikov 2020).

A pilot study on the variability of vessel volumes in settlements in the Sinyukha River Basin (test region A) also provides evidence for a considerable degree of standardisation in ceramic production as an additional argument for certain degrees of specialisation (Shatilo 2021, 190–197). This study also provides possible evidence for changes in storage behaviour associated with the disintegration of large aggregated settlements. This can be seen in a significant reduction in the capacity of storage vessels (Shatilo 2021, 190–197).

Figurines and miniature objects

Anthropomorphic figurines are an important component of the Trypillia societies and one of the most frequently found categories of material (Ţerna 2017). In this work, technological and stylistic descriptions of figurines and other miniature clay objects uncovered during field work in Maidanetske (Chapter 2, this work, Vol. I), Vladimirovka (Chapter 11, this work, Vol. I), Moshuriv (Chapter 12, this work, Vol. I), Apolianka (Chapter 13, this work, Vol. I) and partly from Stolniceni 1 (Chapter 16, this work, Vol. II) are presented. A separate study is devoted to miniature objects from investigated sites in South-Eastern Podolia (Chapter 15, this work, Vol. II).

From this body of materials, it is worth highlighting figurines with 'realistic' details, especially a bull sculpture from Apolianka (see Chapter 13, Fig. 12: 3, this work, Vol. I). The chronological and spatial distribution of settlements with such finds of miniatures with 'realistic' details, published in this book, corresponds to the distribution patterns of similar artefacts traced earlier (Shatilo and Hofmann 2021; Shatilo and Hofmann 2024; Fig. 2H), and contrasts with the distribution of other plastic ('non-realistic') objects, for example, *bird figurines* (see map in Chapter 11, Fig. 36, this work, Vol. I).

Miniature models of cattle drawing sledges and equipment for working animals, concentrated in the Sinyukha River Basin (test region A), indicate significant advances in transportation associated with the largest mega-sites (Shatilo 2017; Shatilo 2021, 228–229; Fig. 2G).

Trypillia plastic objects with 'realistic' details, according to today's knowledge, are related to densely populated regions and agglomerated settlements. This phenomenon may reflect a response to the changing social reality – the formation of large communities – and a need to specify images by giving them individual features (Palaguta and Starkova 2017). Alternatively, it could represent increased stylistic attention in the sense of Wobst's (1977) information-theoretical interpretation that would imply importance in social processes. Moreover, it could mirror the professionalisation of pottery production at Trypillia sites and point to the growing need for social interactions in large socio-cultural high-density settlement networks (Watkins 2008) to maintain a 'sense of community' (ideology) – intensive exchanges and symbolic entertainment (see studies on realistic representations in Trypillia, *e.g.* Burdo 2013; Shatilo and Hofmann 2021; Shatilo and Hofmann 2024).

Bone tools and stone artefacts

Many of the studied sites in the Sinyukha River Basin (test region A) and the Dniester-Southern Bug interfluve (test region B) are characterised by rather sparse data regarding stone, bone and copper tools (Chapter 6, this work, Vol. I). In the case of flint, this may be associated both with a shortage of high-quality flint deposits in some regions (*e.g.* Northern Sinyukha River basin), and with the specific recycling of this material (Pichkur and Shidlovsky 2003, 126; Pichkur and Shidlovsky 2005).

Many sites in both mentioned regions (A and B) are characterised by a remarkable rarity of chipped stone artefacts. However, quite representative data on flint artefacts were obtained for the site of Vladimirovka through surface collections. The industry of this settlement is based on the production of blades, and shows the full cycle of primary and secondary flint processing, as well as maximal usage of local raw materials (Hofmann *et al.* 2019c). Larger series of flint artefacts made from nearby local raw material deposits were also found in the Siret-Dniester interfluve (test region C), in Stolniceni (Țerna *et al.* 2019b) and Trinca.

Additionally, tools made of other materials are often very rare. For Maidanetske this is demonstrated by a pilot study on a very small series of bone artefacts (Chapter 6, this work, Vol. I). Associated with Trypillia B1–B2 and B2 pottery styles, some small objects made of pure copper were found in the Dniester-Southern Bug interfluve (test region B; Hoshko *et al.* 2020).

Consequences: the Trypillia phenomenon

Although our investigations have not yet been completed, we would not like to miss the opportunity to draw a preliminary conclusion on the consequences of the newly obtained results for the interpretation of Trypillia communities and the Trypillia mega-site phenomenon. The project 'Population Agglomerations at Tripolye-Cucuteni Mega-sites' – carried out in close cooperation with regional partners – along with the results of other working groups, provides a considerably extended empirical basis for thinking about the Trypillia phenomenon.

The historical processes that led to the establishment of numerous aggregated settlements and mega-sites were part of the much wider spread of agrarian communities into the forest-steppe zone between the Prut and Dnieper (Harper *et al.* 2023), and were probably associated with both population influx into this region and also considerable intra- and inter-regional population mobility. It is likely that these processes were closely interlinked with the simultaneous development and collapse of tell-centred societies in south-eastern Europe.

The trigger for these large-scale processes may have been climatic changes: first evidences for aridity events, partly dated to the end of the 5th millennium, which may have particularly affected the west of the study area, were recently obtained in sediment cores and archaeobotanical material from the Moldavian plain and further to the southwest in the lower Danube. These climatic events, which are difficult to capture due to the rarity of suitable material and environmental archives, may have lowered the agricultural carrying capacity in the wider Southeast European region and therefore increased the vulnerability of the societies living there; thus, they seem to have contributed to the collapse of these tell-centred communities around 4300/4150 BCE (Harper 2016). Consequently, population agglomeration in Trypillia mega-sites might have been triggered by climate deterioration. The habitus of Trypillia communities, which is influenced in many ways by Southeast European societies, speaks in favour of the direct and active participation of populations from Southeast Europe.

The possibility of Trypillia population agglomerations is based on agro-technological innovations in subsistence economy (intensive manuring) and transport facilities (*e.g.* sledges), but also elaborated pottery kilns for more standardised mass-production. The population agglomerations in mega-sites reached up to 7,500–10,000 inhabitants (Chapter 19, this work, Vol. II).

The systematic study of Trypillia settlement plans has shown that the processes of population aggregation were closely linked to the establishment of well-planned ring-shaped settlement layouts, central elements of which were circumferential so-called ring-streets or ring-corridors and other public spaces. This new type of settlement

configuration, whose predecessors can be traced back to the Carpathian Basin and Transylvania, was probably intended to ensure residents equal access to the central infrastructure facilities of the settlement. In conjunction with other evidence, such as decreasing social inequality (Hofmann *et al.* 2024) and the establishment of a multi-layered system of communal buildings (Hofmann *et al.* 2019b), this settlement configuration points to an egalitarian ideology of the founders of these settlements. With these trajectories in mind, we interpret the establishment of Trypillia mega-sites in concert with other researchers (*e.g.* Graeber and Wengrow 2021; Gaydarska *et al.* 2023) as the result of some kind of 'social experiment' designed to maintain social equality and promote equal participation in political affairs (Arponen *et al.* 2016). Clearly this was successful for an extended period of time.

The, from our perspective, 'progressive' character of the socio-political organisation of these communities contributed decisively to the release of innovative potential, which resulted in extremely important developments, not only in fields such as ceramics production and transport but also in subsistence. Supported by the enormous agricultural potential of the region's loess soils, new forms of intensive agriculture were established, based on intensive pastures for dung production to manure pulses and cereals (Makarewicz *et al.* 2022; Schlütz *et al.* 2023; Kirleis *et al.* 2024). These advanced agricultural strategies increased the carrying capacity of the settlement catchments and were crucial for the nutrition of large local concentrations of people.

While the establishment of the network of aggregated Trypillia communities can most likely be explained as an outcome of a directed occupation process, the disintegration that began from 3800 BCE at the latest appears to be primarily due to internal social processes. The increasing centralisation of decision-making processes, visible in the development of communal integrative institutions, and the renewed increase in social inequality, visible in floor size variability, challenged the ideological foundation and the equal cooperation of the residents in the reality of their lives in large settlements; probably forming the decisive factor for the fission of the communities.

It must be emphasised that there is considerable interregional diversity of trajectories within the extensive network of Trypillia communities. This diversity not only concerns the scale and duration of local and regional population aggregations, but also affects other spheres. Accordingly, the intensive mega-site economy was only established in the Sinyukha River Basin (test region A) and the Dniester-Southern Bug interfluve (test region B; Schlütz *et al.* 2023), while exclusively extensive strategies were pursued in the Siret-Dniester interfluve (test region C). The spatial concentration of realistic-style pictorial representations associated with the population concentration in the Sinyukha River Basin indicates their communicative role related to higher degrees of social complexity (Shatilo and Hofmann 2024). Consequently, the regional differences are most likely due to differences in social dynamics and are rooted in different population densities and in the field of political economy.

The relationship between different degrees of population concentration and the socio-political organisation of Trypillia communities is manifested, among other things, in the number of communal buildings as proxy for the number of hierarchical decision-making levels. We assume that not all organisational levels can be identified in magnetic plans, as could be demonstrated for Stolniceni (Chapter 16, this work, Vol. II; cf. also Arponen *et al.* 2016)

The frequent occurrence of low-level mega-structures in large settlements of the Sinyukha River Basin on the one hand, and the absence of this lower (or middle?) level in most settlements to the west on the other hand, indicates regional differences in the organisation of integrative activities and decision-making processes. According to our interpretation, it was the obviously more strongly developed political

participation of broad parts of the population that might have been responsible for the special attractiveness of settlements in this region and caused their unusual large dimensions in terms of population size.

References

Arponen, V.P.J., Müller, J. and Ohlrau, R., 2016. Artefacts, houses, and inequality. *In*: H. Meller, H.P. Hahn, R. Jung and R. Risch, eds. A*rm und Reich – Zur Ressourcenverteilung in prähistorischen Gesellschaften. 8. Mitteldeutscher Archäologentag vom 22. bis 24. Oktober 2015 in Halle (Saale)* / *Rich and Poor – Competing for resources in prehistoric societies. 8th Archaeological Conference of Central Germany, October 22–24, 2015 in Halle (Saale)*. Tagungen des Landesmuseums für Vorgeschichte Halle 14/I. Halle/Saale: Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt – Landesmuseum für Vorgeschichte, 49–60.

Brandtstätter, L., 2017. *Tripolje-Keramik aus Maidanteske (Ukraine): Auswertung der Grabungskampagne 2013*. [Unpublished Master thesis. Institute of Prehistoric and Protohistoric Archaeology, Kiel University, Germany].

Burdo 2013: Бурдо, Н.Б., 2013. *Реалистическая пластика культурного комплекса Триполье-Кукутень. Систематзация, типология, интерпретация*. Saarbrücken: LAP Lambert Academic Publishing.

Chapman, J., Videiko, M.Y., Gaydarska, B., Burdo, N. and Hale, D., 2014a. Architectural diferentiation on a Trypillia mega-site: preliminary report on the excavation of a mega-structure at Nebelivka, Ukraine. *Journal of Neolithic Archaeology*, 16, 135–156. Available from: DOI:10.12766/jna.2014.4

Chapman, J., Videiko, M.Y., Hale, D., Gaydarska, B., Burdo, N., Rassmann, K., Mischka, C., Müller, J., Korvin-Piotrovskiy, A.G. and Kruts, V., 2014b. The Second Phase of the Trypillia Mega-Site Methodological Revolution: A New Research Agenda. *European Journal of Archaeology,* 17 (3), 369–406. Available from: DOI:10.1179/1461957114Y.0000000062

Chernovol 2023: Черновол, Д.К., 2023. До питання великих споруд трипільської культури / The issue of the large dwellings of Trypillia Culture. Археологія і давня історія України, 46 (1), 222–232. Available from: DOI:10.37445/adiu.2023.01.14

Dal Corso, M., Out, W.A., Ohlrau, R., Hofmann, R., Dreibrodt, S., Videiko, M., Müller, J. and Kirleis, W., 2018. Where are the cereals? Contribution of phytolith analysis to the study of subsistence economy at the Trypillia site Maidanetske (ca. 3900-3650 BCE), central Ukraine. *Journal of Arid Environments*, 157, 137–148. Available from: DOI:10.1016/j.jaridenv.2018.06.009

Dal Corso, M., Hamer, W., Hofmann, R., Ohlrau, R., Shatilo, L., Knitter, D., Dreibrodt, S., Saggau, P., Duttmann, R., Feeser, I., Knapp, H., Benecke, N., Videiko, M., Müller, J. and Kirleis, W., 2019. Modelling landscape transformation at the Chalcolithic Tripolye mega-site of Maidanetske (Ukraine): Wood demand and availability. *The Holocene,* 29 (10), 1622–1636. Available from: DOI:10.1177/0959683619857229

Dergachev 1980: Дергачев, В.А., 1980. Памятники позднего энеолита (опыт систематизации). Кишинев: Штиинца.

Dreibrodt, S., Hofmann, R., Sipos, G., Schwark, L., Videiko, M., Shatilo, L., Martini, S., Saggau, P., Bork, H.-R., Kirleis, W., Duttmann, R. and Müller, J., 2020. Holocene soil erosion in Eastern Europe-land use and/or climate controlled? The example of a catchment at the Giant Chalcolithic settlement at Maidanetske, central Ukraine. *Geomorphology*, 367, 107302. Available from: DOI:10.1016/j.geomorph.2020.107302

Dreibrodt, S., Hofmann, R., Dal Corso, M., Bork, H.-R., Duttmann, R., Martini, S., Saggau, P., Schwark, L., Shatilo, L., Videiko, M., Nadeau, M.-J., Grootes, P.M., Kirleis, W. and Müller, J., 2022. Earthworms, Darwin and prehistoric agriculture-Chernozem genesis reconsidered. *Geoderma*, 409, 115607. Available from: DOI:10.1016/j.geoderma.2021.115607

Fuchs, K., Hofmann, R., Shatilo, L., Schlütz, F., Storch, S., Chabanyuk, V., Kirleis, W. and Müller, J., 2023. Life and death in Trypillia times: Interdisciplinary analyses of the exceptional human remains from the settlement of Kosenivka, Ukraine (3700–3600 BCE). *PLOS One*. Available from: DOI:10.1371/journal.pone.0289769

Gaydarska, B., ed., 2020. *Early Urbanism in Europe. The Trypillia Megasites of the Ukrainian Forest-Steppe*. Warsaw, Berlin: De Gruyter. Available from: DOI:10.1515/9783110664959

Gaydarska, B., Millard, A., Buchanan, B. and Chapman, J., 2023. Place and Time at Trypillia Mega-Sites: Towards a New Synthesis of Analyses and Social Theory. *Journal of Urban Archaeology*, 7, 115–145. Available from: DOI:10.1484/J.JUA.5.133453

Graeber, D. and Wengrow, D., 2021. *The Dawn of Everything. A New History of Humanity*. London: Allen Lane.

Hale, D., 2020. Geophysical Investigations and the Nebelivka Site Plan. *In:* B. Gaydarska, ed. *Early Urbanism in Europe. The Trypillia Megasites of the Ukrainian Forest-Steppe*. Warsaw, Berlin: De Gruyter, 122–148. Available from: DOI:10.1515/9783110664959-008

Harper, T.K., 2016. *Climate, migration, and false cities on the Old European periphery: a spatial-demographic approach to understanding the Tripolye giant-settlements*. [Unpublished PhD thesis. University at Buffalo, State University of New York].

Harper, T.K., Diachenko, A., Rassamakin, Y.Y., Chernovol, D.K., Shumova, V.A., Nechitailo, P., Chabaniuk, V.V., Tsvek, E.V., Bilas, N.M., Pohoralskyi, Y.V., Eccles, L.R., Kennett, D.J. and Ryzhov, S.N., 2021. Combining relative chronology and AMS ^{14}C dating to contextualize 'megasites', serial migrations and diachronic expressions of material culture in the Western Tripolye culture, Ukraine. *Documenta Praehistorica*, 48, 276–296. Available from: DOI:10.4312/dp.48.11

Harper, T.K., Diachenko, A., Ryzhov, S.N., Rassamakin, Y.Y., Eccles, L.R., Kennett, D.J. and Tsvek, E.V., 2023. Assessing the spread of Eneolithic agricultural communities in the forest-steppe of Ukraine using AMS radiocarbon dating. *Radiocarbon*, 65 (3), 643–663. Available from: DOI:10.1017/RDC.2023.28

Hofmann, R., Țerna, S., Ursu, C.-E., Brandtstätter, L., Tiede, H., Mainusch, W. and Authenrieth, S., 2016. Spatial organization and population size of small Cucuteni-Tripolye settlements: Results of geomagnetic surveys in Baia and Adâncata, Suceava County, Bucovina, Eastern Romania. *Journal of Neolithic Archaeology*, 18, 157–189. Available from: DOI:10.12766/jna.2016.4

Hofmann, R., Shatilo, M., Ohlrau, R., Dal Corso, M., Dreibrodt, S., Videiko, M., Rassmann, K., Kirleis, W. and Müller, J., 2018. Tripolye – Strategy and Results of an ongoing Ukrainian-European Project. *Vita Antiqua*, 10, 146–154. Available from: DOI:10.37098/2519-4542-2018-1-10-146-154.

Hofmann, R., Medović, A., Furholt, M., Medović, I., Stanković-Pešterac, T., Dreibrodt, S., Martini, S. and Hofmann, A., 2019a. Late Neolithic multicomponent sites of the Tisza region and the emergence of centripetal settlement layouts. *Praehistorische Zeitschrift*, 94 (2), 351–378. Available from: DOI:10.1515/pz-2019-0003

Hofmann, R., Müller, J., Shatilo, L., Videiko, M., Ohlrau, R., Rud, V., Burdo, N., Dal Corso, M., Dreibrodt, S. and Kirleis, W., 2019b. Governing Tripolye: Integrative architecture in Tripolye settlements. *PLoS ONE*, 14 (9), e0222243. Available from: DOI:10.1371/journal.pone.0222243

Hofmann *et al*. 2019c: Хофманн, Р., Шатіло, Л.О. and Пічкур, Є.В., 2019c. Нові розвідкина Трипільських поселеннях Буго-Дніпровського межиріччя: колекція крем'яних знахідок / New Explorations of the Trypillia Settlements of Bugh-Dnieper Interfluve: a collection of flint finds. *Vita Antiqua,* 11, 144–158. Available from: DOI:10.37098/VA-2019-11-144-158

Hofmann, R., Müller-Scheeßel, N. and Müller, J., 2024. Trypillia mega-sites: a social levelling concept? *Antiquity*, 98 (398), 380–400. Available from: DOI:10.15184/aqy.2024.18

Hoshko *et al*. 2020: Гошко, Т., Рудь, В. and Хофманн, Р., 2020. Нові знахідки мідних виробів трипільської культури з басейнів Дністра та Південного Бугу. *Київські історичні студії: науковий журнал*, 2 (11), 81–85. Available from: DOI:10.28925/2524-0757.2020.2.11

Kirleis, W., Dal Corso, M., Pashkevych, G., Schlütz, F., Hofmann, R., Terna, A., Dreibrodt, S., Rud, V., Videiko, M.Y. and Müller, J., 2024. A complex subsistence regime revealed for Cucuteni–Trypillia sites in Chalcolithic eastern Europe based on new and old macrobotanical data. *Vegetation History and Archaeobotany*, 33, 75–90. Available from: DOI:10.1007/s00334-023-00936-y

Korvin-Piotrovskiy and Ovchinnikov 2020: Корвин-Пиотровский, А.Г. and Овчинников, Э.В., 2020. Виробничі об'єкти комплексу «Сім'я гончара» на трипільському поселенні Тальянки. Емінак, 25 (1), 254–276.

Korvin-Piotrovskiy, A., Hofmann, R., Rassmann, K., Videiko, M.Y. and Brandtstätter, L., 2016a. Pottery Kilns in Trypillian Settlements. Tracing the Division of Labour and the Social Organization of Copper Age Communities. *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE.* Themes in Contemporary Archaeology 2. London, New York: Routledge, 221–252. Available from: DOI:10.4324/9781315630731

Korvin-Piotrovskiy *et al.* 2016b: Корвін-Піотровський, О.Г., Пічкур, Є.В., Чабанюк, В.В. and Шатіло, Л.О., 2016. Черкаська область. Роботи Трипільської експедиції. Археологічні дослідження в Україні, 2015, 201–203.

Kristiansen, K., 2022. *Archaeology and the Genetic Revolution in European Prehistory*. Elements in the Archaeology of Europe. Cambridge: Cambridge University Press. Available from: DOI:10.1017/9781009228701

Kruts 1989: Круц, В.А., 1989. К истории населения трипольской культуры в междуречье Южного Буга и Днепра. *In*: С.С. Березанская, ed. Первобытная археология. Материалы и исследования. Київ: Издательство «Наукова думка», 117–132.

Kruts 1990: Круц, В.А., 1990. Планировка поселения у с. Тальянки и некоторые вопросы трипольского домостроительства. *In*: В.Г. Збенович *et al*., eds. Раннеземледельческие поселения-гиганты трипольской культуры на Украине. Тез. докл. 1-го полевого семинара. Тальянки, Веселый Кут, Майданецкое: Институт археологии НАН Украины, 43–47.

Makarewicz, C.A., Hofmann, R., Videiko, M.Y. and Müller, J., 2022. Community negotiation and pasture partitioning at the Trypillia settlement of Maidanetske. *Antiquity*, 96 (388), 831–847. Available from: DOI:10.15184/aqy.2022.32

Markevich 1981: Маркевич, В.И., 1981. *Позднетрипольские племена северной Молдавии*. Кишинев: Штиинца.

Menotti, F. and Korvin-Piotrovskiy, A.G., eds., 2012. *The Tripolye Culture Giant-Settlements in Ukraine. Formation, Development and Decline*. Oxford: Oxbow Books. Available from: DOI:10.2307/j.ctvh1dvmn

Millard, A., 2020. The AMS Dates. *In*: B. Gaydarska, ed. *Early urbanism in Europe. The Trypillia megasites of the Ukrainian forest-steppe*. Warsaw, Berlin: De Gruyter, 246–256. Available from: DOI:10.1515/9783110664959-008

Movsha 1984: Мовша, Т.Г., 1984. Хронология Триполья-Кукутени и степные культуры эпохи раннего металла в ее системе. *In*: И.Ф. Ковалева, ed. Проблемы археологии Поднепровья. Днепропетровск: Днепропетровский государственный университет, 60–83.

Müller, J. and Videiko, M., 2016. Maidanetske: New Facts of a Mega-Site *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE.* Themes in Contemporary Archaeology 2. London, New York: Routledge, 71–93. Available from: DOI:10.4324/9781315630731

Müller, J., Hofmann, R., Brandtstätter, L., Ohlrau, R. and Videiko, M., 2016a. Chronology and Demography: How Many People Lived in a Mega-Site? *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE.* Themes in Contemporary Archaeology 2. London, New York: Routledge, 133–170. Available from: DOI:10.4324/9781315630731

Müller, J., Hofmann, R. and Ohlrau, R., 2016b. From Domestic Households to Mega-Structures: Proto-Urbanism? *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE.* Themes in Contemporary Archaeology 2. London, New York: Routledge, 253–268. Available from: DOI:10.4324/9781315630731

Müller, J., Rassmann, K. and Videiko, M., eds., 2016c. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE.* Themes in Contemporary Archaeology 2. London, New York: Routledge. Available from: DOI:10.4324/9781315630731

Müller, J., Hofmann, R., Kirleis, W., Dreibrodt, S., Ohlrau, R., Brandtstätter, L., Dal Corso, M., Out, W., Rassmann, K., Burdo, N. and Videiko, M., eds., 2017. *Maidanetske 2013. New excavations at a Trypillia mega-site* / Майданецьке *2013.* Нові розкопки великого Трипільського поселення. Studien zur Archäologie in Ostmitteleuropa 16. Bonn: Dr. Rudolf Habelt.

Müller, J., Hofmann, R., Ohlrau, R. and Shatilo, M., 2018. The social constitution and political organisation of Tripolye mega-sites: hierarchy and balance. *In*: H. Meller, D. Gronenborn and R. Risch, eds. Überschuss ohne Staat – Politische Formen in der Vorgeschichte. *10. Mitteldeutscher Archäologentag vom 19. bis 21. Oktober 2017 in Halle (Saale)* / *Surplus without the State – Political Forms in Prehistory. 10th Archaeological Conference of Central Germany, October 19–21, 2017 in Halle (Saale).* Tagungen des Landesmuseums für Vorgeschichte Halle 18. Halle/Saale: Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt – Landesmuseum für Vorgeschichte, 247–262.

Müller, J., Hofmann, R. and Shatilo, M., 2022a. Tripolye Mega-Sites: "Collective Computational Abilities" of Prehistoric Proto-Urban Societies? *Journal of Social Computing*, 3 (1), 75–90. Available from: DOI:10.23919/JSC.2021.0034

Müller, J., Hofmann, R., Videiko, M. and Burdo, N., 2022b. Nebelivka – rediscovered: A Lost City. *In*: M. Dębiec, J. Gorski, J. Müller, M. Nowak, A. Pelisiak, T. Saile and P. Włodarczak, eds. *From Farmers to Heroes? Archaeological Studies in Honor of Sławomir Kadrow*. Universitätsforschungen zur prähistorischen Archäologie 376. Bonn: Dr. Rudolf Habelt, 213–222.

Müller, J., Hofmann, R., Sîrbu, G., Heghea, S., Țerna, A., Fuchs, K., Shatilo, L., Schlütz, F. and Kirleis, W., 2023. Trinca-La Șanț – A Large North Moldovan Trypillia Settlement. *Journal of Neolithic Archaeology*, 25, 243–262. Available from: DOI:10.12766/jna.2023.9

Ohlrau, R., 2015. Trypillia Großsiedlungen: Geomagnetische Prospektion und architektursoziologische Perspektiven. *Journal of Neolithic Archaeology*, 17, 17–100. Available from: DOI:10.12766/jna.2015.3

Ohlrau, R., 2020a. *Maidanets'ke: Development and decline of a Trypillia mega-site in Central Ukraine*. Scales of Transformation in Prehistoric and Archaic Societies 7. Leiden: Sidestone Press. Available from: DOI:10.59641/h0912kt

Ohlrau, R., 2020b. Modelling Trypillia 'mega-site' populations. *In*: M. Dębiec and T. Saile, eds. *A Planitiebus usque ad montes: Studia Archaeologica Andreae Pelisiak vitae anno sexagesimo quinto oblata*. Rzeszów: Zimowit, 399–413.

Ohlrau, R., 2022. Trypillia Mega-Sites. Neither Urban nor Low-Density? *Journal of Urban Archaeology*, 5, 81–100. Available from: DOI:10.1484/J.JUA.5.129844

Ohlrau, R. and Rud, V., 2019. Testing Trypillian site development via geomagnetic survey – New "mega-structures" and plans of smaller sites. *In*: D. Mischka, C. Mischka and C. Preoteasa, eds. *Beyond Excavation. Geophysics, Aerial Photography and the Use of Drones in Eastern and Southeastern European Archaeology. Proceedings of the International Colloquium, 5-8 December 2016, Piatra-Neamț, Romania*. Bibliotheca Memoriae Antiquitatis 40; Erlanger Studien zur Prähistorischen Archäologie 3. Piatra-Neamț: Editura "Constantin Matasă", 87–113.

Orton, D., Nottingham, J., Rainsford-Betts, G., Hosking, K. and Millard, A., 2020. Animal Bones. *In:* B. Gaydarska, ed. *Early Urbanism in Europe. The Trypillia Megasites of the Ukrainian Forest-Steppe*. Warsaw, Berlin: De Gruyter, 388–409. Available from: DOI:10.1515/9783110664959-009

Palaguta, I.V. and Starkova, E.G., 2017. A House Model from Popudnya, Cucuteni-Tripolye Culture, Ukraine: A New Interpretation. *Archaeology, Ethnology & Anthropology of Eurasia*, 45 (1), 83–92. Available from: DOI:10.17746/1563-0110.2017.45.1.083-092

Passek 1949: Пассек, Т.С., 1949. Периодизация трипольских поселений *(III–II* тыс. до н.э*.)*. Материалы и исследования по археологии СССР (МИА) 10. Москва, Ленинград: Издательство Академии наук СССР.

Pichkur and Shidlovsky 2003: Пічкур Є.В. and Шидловський П.С., 2003. Комплекс кременеобробки поселення Пекарі II. *In*: О.Г. Корвін-Піотровський, В.О. Круц and С.М. Рижов, eds. Трипільські поселення-гіганти. Матеріали міжнародної конференції / *Tripolian settlements-giants. The international symposium materials*. Київ: Корвін Пресс, 121–128.

Pichkur and Shidlovsky 2005: Пічкур Є.В. and Шидловський П.С., 2005. До питання про роль місцевого та імпортного (волинського) кременю в кременеобробці трипільських племен Буго-Дніпровського межиріччя. *In*: Н.Н. Скакун, Е.В. Цвек, В.А. Круц, Б.И. Матева, А.Г. Корвин-Пиотровский, А. Самзун and Л.М. Яковлева, eds. Археологические исследования трипольского поселения Бодаки в 2005 г. Киев, Санкт-Петербург: Корвин Пресс, 109–123. Available from: https://zenodo.org/doi/10.5281/zenodo.1215105

Pickartz, N., Hofmann, R., Dreibrodt, S., Rassmann, K., Shatilo, L., Ohlrau, R., Wilken, D. and Rabbel, W., 2019. Deciphering archeological contexts from the magnetic map: Determination of daub distribution and mass of Chalcolithic house remains. *The Holocene*, 29 (10), 1637–1652. Available from: DOI:10.1177/0959683619857238

Pickartz, N., Rabbel, W., Rassmann, K., Hofmann, R., Ohlrau, R., Thorwart, M., Wilken, D., Wunderlich, T., Videiko, M. and Müller, J., 2022. Inverse Filtering of Magnetic Prospection Data—A Gateway to the Social Structure of Cucuteni–Tripolye Settlements? *Remote Sensing*, 14 (3), 484. Available from: DOI:10.3390/rs14030484

Rassmann, K., Ohlrau, R., Hofmann, R., Mischka, C., Burdo, N., Videjko, M.Y. and Müller, J., 2014. High precision Tripolye settlement plans, demographic estimations and settlement organization. *Journal of Neolithic Archaeology*, 16, 96–134. Available from: DOI:10.12766/jna.2014.3

Rud, V., Hofmann, R., Kosakivskyi, V., Zaitseva, O. and Müller, J., 2019a. Trypillia Megasites West of the River Southern Buh: Preliminary Results of Bilyi Kamin Site Investigation in 2018. *Journal of Neolithic Archaeology*, 21, 27–60. Available from: DOI:10.12766/jna.2019.2

Rud, V., Zaitseva, O., Hofmann, R., Rauba-Bukowska, A. and Kosakivsky, V., 2019b. Unique Pottery Kiln Construction? The Interpretation of Massive Clay Objects from the Trostianchyk Site of the Trypillia Culture. *Sprawozdania archeologiczne*, 71, 11–39. Available from: DOI:10.23858/sa71.2019.001

Rud *et al.* 2019c: Рудь, В., Хофманн, Р., Косаківський, В., Зайцева, О. and Мюллер, Й., 2019c. Білий Камінь: планування найбільшого поселення трипільської культури межиріччя Південного Бугу та Дністра. Археологія та давня історія України, 4 (33), 362–372. Available from: http://dspace.nbuv.gov.ua/bitstream/handle/123456789/167215/32-Rud.pdf?sequence=1

Rud, V., Hofmann, R., Kosakivskyi, V., Zaitseva, O. and Müller, J., 2023. The structure of the Cucuteni–Trypillia multilayered site Kisnytsia on the middle Dnister (Ukraine). *In*: V. Cotiugă, F.-A. Tencariu and A. Asăndulesei, eds. *Fontes perennitatis: Studia in honorem magistri Nicolae Ursulescu octogesimum annum peragentis*. Târgovişte: Cetatea de scaun, 281–294.

Rybicka, M., Wacnik, A., Pokutta, D., Kittel, P., Okupny, D., Król, D., Sady-Bugajska, A., Pankowski, W., Sîrbu, G., Makohonienko, M. and Słowiński, M., 2023. Was Gordineşti II-Stînca Goala abandoned due to cultural changes or environmental impacts? A case of the late Trypillia settlement in northern Moldova. *Sprawozdania Archeologiczne*, 75 (1), 51–75. Available from: DOI:10.23858/Sa/75.2023.1.3471

Ryzhov 1990: Рыжов, С.Н., 1990. Микрохронология трипольского поселения у с. Тальянки. *In*: В.Г. Збенович *et al*., eds. Раннеземледельческие поселения-гиганты трипольской культуры на Украине. Тез. докл. 1-го полевого семинара. Тальянки, Веселый Кут, Майданецкое: Институт археологии НАН Украины, 83–90.

Ryzhov 1999: Рижов, С.М., 1999. Кераміка Поселень Трипільської Культури Буго-Дніпровського Межиріччя Як Історичне Джерело. [Unpublished PhD thesis. Національна Академія Наук України].

Ryzhov 2007: Рижов, С.М., 2007. Сучасний стан вивчення культурно-історичної спільності Кукутень-Трипілля на території України. *In*: О. Ольжич (original author), Ю. Рассамакін and С. Рижов, eds. Археологія, Vol. 2. Київ: Вид-во ім. Олени Теліги, 437–477.

Ryzhov, S.N., 2012a. Relative Chronology of the Giant-settlement Period BII–CI. *In:* F. Menotti and A.G. Korvin-Piotrovskiy, eds. *The Tripolye Culture giant-settlements in Ukraine: Formation, development and decline*. Oxford, Oakville: Oxbow Books, 79–115. Available from: DOI:10.2307/j.ctvh1dvmn.9

Ryzhov, S.N., 2012b. Tripolian Pottery of the Giant-settlements: Characteristics and Typology. *In:* F. Menotti and A.G. Korvin-Piotrovskiy, eds. *The Tripolye Culture giant-settlements in Ukraine: Formation, development and decline*. Oxford, Oakville: Oxbow Books, 139–168. Available from: DOI:10.2307/j.ctvh1dvmn.11

Schlütz, F., Hofmann, R., Dal Corso, M., Pashkevych, G., Dreibrodt, S., Shatilo, M., Terna, A., Fuchs, K., Videiko, M., Rud, V., Müller, J. and Kirleis, W., 2023. Isotopes prove advanced, integral crop production, and stockbreeding strategies nourished Trypillia mega-populations. *PNAS*, 120 (52), e2312962120. Available from: DOI:10.1073/pnas.2312962120

Shatilo, L., 2017. Ornaments and Signs on the Sledge Models from Talianki (Excavation 2012) – Art Decor or a source of information? *In*: C.-E. Ursu, A. Poruciuc and C.-M. Lazarovici, eds. *Symbols and Signs as a Communication System. Papers presented at the international symposium "From Symbols to Signs. Signs, Symbols, Rituals in sanctuaries" Suceava, Romania, 9-11 September 2016. In memory of Gheorge Dumitroaia*. Ethnoreligion Series III. Suceava: Editura Karl A. Romstorfer, 177–185.

Shatilo, L., 2021. *Tripolye Typo-chronology: Mega and Smaller Sites in the Sinyukha River Basin.* Scales of Transformation in Prehistoric and Archaic Societies 12. Leiden: Sidestone Press. Available from: DOI:10.59641/m5457py

Shatilo, L., in prep. *Sources on Land Transport of the 4th mill. BC in Europe: re-evaluation and analysis*.

Shatilo and Hofmann 2021: Шатіло, Л. and Хофманн, Р., 2021. Зображуючи Трипілля: поява та занепад реалістичного стилю / Depicting Trypillia: the emergence and decline of realistic style. Археологія *і* давня історія України, 39 (2), 198–221. Available from: DOI:10.37445/adiu.2021.02.11

Shatilo, L. and Hofmann, R., 2024. Depicting Trypillia: Emergence and Transformation of the Realistic Style. *In*: J. Müller, W. Kirleis and N. Taylor, eds. *Perspectives on Socio-environmental Transformations in Ancient Europe*. Cham: Springer, 221–256. Available from: DOI:10.1007/978-3-031-53314-3

Shishkin 1985: Шишкін, К.В., 1985. Планування трипільських поселень за даними аерофотозйомки. Археологія, 52, 72–77. Available from: http://dspace.nbuv.gov.ua/handle/123456789/197056

Shmagliy and Videiko 1990: Шмаглий, Н.М. and Видейко, М.Ю., 1990. Микрохронология поселения Майданецкое. *In*: В.Г. Збенович *et al*., eds. Раннеземледельческие поселения-гиганты трипольской культуры на Украине. Тез. докл. 1-го полевого семинара. Тальянки, Веселый Кут, Майданецкое: Институт археологии НАН Украины, 91–94.

Shmagliy and Videiko 2001-2002: Шмаглий, Н.М. and Видейко, М.Ю., 2001-2002. Майданецкое – трипольский протогород. *Stratum Plus*, 2001-2002 (2), 44–140.

Țerna 2017: Церна, С., 2017. К вопросу о распространении мелкой антропоморфной пластики на поселениях культуры Кукутень-Триполье / The issue of portable art occurrence at the Cucuteni-Tripolye sites. Краткие сообщения Института археологии, 247, 223–244. Available from: https://sciup.org/143163916

Țerna, S., 2021. How can we investigate the socio-economic structure of the Cucuteni-Tripolye mega-sites? Houses as Snapshots and Pits as Durable Narratives. *Archäologisches Korrespondenzblatt*, 51 (1), 37–60. Available from: DOI:10.11588/ak.2021.1.86862

Țerna, S. and Vornicu-Țerna, A., 2021. The potential of google Earth spatial imagery for detecting Cucuteni-Tripolye settlements: Some examples from ongoing investigation (Republic of Moldova and Northeastern Romania). *In*: A. Diachenko, T.K. Harper, Y. Rassamakin and I. Sobkowiak-Tabaka, eds. *Data Systematization in the Neo-Eneolithic of Southeastern and Central Europe. Essays in honor of Sergej Ryzhov* / Систематизація неолітичних і енеолітичних матеріалів Південно-Східної та Центральної Європи. Збірка наукових праць на пошану Сергія Рижова. Kyiv: Institute of Archaeology of the National Academy of Sciences of Ukraine, 265–305.

Țerna, S., Rassmann, K., Vornicu-Țerna, A. and Müller, J., 2019a. The evolution of dual-chambered updraught kilns on the Cucuteni-Tripolye mega-sites in the 4th millennium BC: a view from Stolniceni. *Godišnjak*, 48, 41–58. Available from: DOI:10.5644/Godisnjak.CBI.ANUBiH-48.116

Țerna, S., Vornicu-Țerna, A., Hofmann, R., Dal Corso, M., Shatilo, L., Vasilache-Curoşu, M., Rud, V., Knapp, H., Kirleis, W., Rassmann, K. and Müller, J., 2019b. Stolniceni – Excavation results from the 2017 campaign. *Journal of Neolithic Archaeology*, 21, 209–282. Available from: DOI:10.12766/jna.2019.9

Tsvek 1989: Цвек, Е.В., 1989. Буго-днепровский вариант восточнотрипольской культуры: К пробл. выделения культур и локал. вариантов Триполья. *In*: С.С. Березанская, ed. Первобытная археология. Материалы и исследования. Київ: Издательство «Наукова думка», 106–117.

Videiko and Burdo 2004: Відейко, М.Ю. and Бурдо, Н.Б., eds., 2004. Енциклопедія Трипільської Цивілізації, Vol. 1–2. Київ: Укрполіграфмедіа. Available from: https://archive.org/details/trypillia

Videiko, M. and Rassmann, K., 2016. Research on Different Scales: 120 Years of Trypillian Large Sites Research. *In*: J. Müller, K. Rassmann and M. Videiko, eds. *Trypillia Mega-Sites and European Prehistory 4100-3400 BCE.* Themes in Contemporary Archaeology 2. London, New York: Routledge, 17–28. Available from: DOI: 10.4324/9781315630731

Vinogradova 1972: Виноградова, Н.М., 1972. Памятники переходного этапа Триполья BI–BII в Поднестровье. Советская археология, 1972 (1), 36–56.

Vinogradova 1973: Виноградова, Н.М., 1973. Памятники переходного этапа Триполья BI–BII в Побужье и Поднепровье. Краткие сообщения Института археологии, 134, 20–27.

Wagner, T., 2019. An-Architektur. Politische Aspekte der Siedlungsformen primitiver Gesellschaften. *In*: R. Haude and T. Wagner, eds. *Herrschaftsfreie Institutionen. Texte zur Stabilisierung staatenloser, egalitärer Gesellschaften*. Heidelberg: Verlag Graswurzelrevolution.

Watkins, T., 2008. Supra-Regional Networks in the Neolithic of Southwest Asia. *Journal of World Prehistory*, 21, 139–171. Available from: DOI: 10.1007/s10963-008-9013-z

Wobst, H.M., 1977. Stylistic behaviour and information exchange. *In*: C.E. Cleland, ed. *For the Director: research essays in honour of James B Griffin*. Anthropological Papers 61. Ann Arbor: Museum of Anthropology, University of Michigan, 317–342. Available from: DOI: 10.3998/mpub.11395371

Zbenovič 1990: Збенович, В.Г., 1990. К проблеме крупных трипольских поселений. *In*: В.Г. Збенович *et al*., eds. Раннеземледельческие поселения-гиганты трипольской культуры на Украине. Тез. докл. 1-го полевого семинара. Тальянки, Веселый Кут, Майданецкое: Институт археологии НАН Украины, 10–12.

STPAS: Scales of Transformation in Prehistoric and Archaic Societies

The book series ‘Scales of Transformation in Prehistoric and Archaic Societies’ (STPAS) is an international scientific series that covers major results deriving from or being associated with the research conducted in the Collaborative Research Centre ‘Scales of Transformation: Human-Environmental Interaction in Prehistoric and Archaic Societies’ (CRC 1266). Primarily located at Kiel University, Germany, the CRC 1266 is a large interdisciplinary project investigating multiple aspects of socio-environmental transformations in ancient societies between 15,000 and 1 BCE across Europe.

Volume 1
Das Jungneolithikum in Schleswig-Holstein
Sebastian Schultrich | 2018
ISBN: 9789088907425
Format: 210x280mm | 506 pp. | Language: German | 43 illus. (bw) | 103 illus. (fc)
Keywords: Late Neolithic, Single Grave Culture, Corded Ware Culture, transformation, solid stone axe, battle axe, fragments of axes | Jungneolithikum, Einzelgrabkultur, Schnurkeramische Kultur, Transformation, Felsgesteinäxte, Streitäxte, Axtfragmente

Volume 2
Embracing Bell Beaker
Adopting new ideas and objects across Europe during the later 3rd millennium BC (c. 2600-2000 BC)
Jos Kleijne | 2019
ISBN: 9789088907555
Format: 210x280mm | 300 pp. | Language: English | 91 illus. (fc)
Keywords: archaeology; Late Neolithic; Bell Beaker phenomenon; settlement archaeology; innovation; network analysis; mobility; prehistoric potter

Volume 3
Habitus?
The Social Dimension of Technology and Transformation
Edited by Sławomir Kadrow & Johannes Müller | 2019
ISBN: 9789088907838
Format: 210x280mm | 232 pp. | Language: English | 15 illus. (bw) | 65 illus. (fc)
Keywords: European prehistory; archaeology; habitus; technology; transformation; social dimension; ethnoarchaeology

Volume 4
How's Life?
Living Conditions in the 2nd and 1st Millennia BCE
Edited by Marta Dal Corso, Wiebke Kirleis, Jutta Kneisel, Nicole Taylor, Magdalena Wieckowska-Lüth, Marco Zanon | 2019
ISBN: 9789088908019
Format: 210x280mm | 220 pp. | Language: English | 29 illus. (bw) | 43 illus. (fc)
Keywords: Bronze Age, domestic archaeology, household archaeology, daily life, routine activities, diet, waste, violence, health, natural resources, food production

Volume 5
Megalithic monuments and social structures
Comparative studies on recent and Funnel Beaker societies
Maria Wunderlich | 2019
ISBN: 9789088907869
Format: 210x280mm | 382 pp. | Language: English | 114 illus. (bw) | 246 illus. (fc)
Keywords: Megalithic graves, monumentality, Funnel Beaker Complex, ethnoarchaeology, Sumba, Nagaland, social organisation, cooperation

Volume 6
Gender Transformations in Prehistoric and Archaic Societies
Edited by Julia Katharina Koch & Wiebke Kirleis | 2019
ISBN: 9789088908217
Format: 210x280mm | 502 pp. | Language: English | 114 illus. (bw) | 58 illus. (fc)
Keywords: academic fieldwork; gender archaeology; social archaeology; environmental archaeology; history of archaeology; Mesolithic; Neolithic; Bronze Age; Iron Age; Europe; South-west Asia; Central Asia

Volume 7
Maidanets'ke
Development and decline of a Trypillia mega-site in Central Ukraine
René Ohlrau | 2020
ISBN: 9789088908484
Format: 210x280mm | 326 pp. | Language: English | 141 illus. (bw) | 93 illus. (fc)
Keywords: settlement archaeology; prehistoric archaeology; early urbanism; geophysical survey; paleodemography; Trypillia; mega-site

Volume 8
Detecting and explaining technological innovation in prehistory
Edited by Michela Spataro & Martin Furholt | 2020
ISBN: 9789088908248
Format: 210x280mm | 248 pp. | Language: English | 22 illus. (bw) | 37 illus. (fc)
Keywords: archaeology; prehistory; technology; innovation; invention; tradition; chaîne opératoire; knowledge acquisition; knowledge transfer; Neolithic; Bronze Age; Iron Age; ethnography; ceramic; metal; bone

Volume 9
Archaeology in the Žitava Valley I
The LBK and Želiezovce settlement site of Vráble
Edited by Martin Furholt, Ivan Cheben, Johannes Müller, Alena Bistáková, Maria Wunderlich & Nils Müller-Scheeßel | 2020
ISBN: 9789088908972

Format: 210x280 | 546 pp. | Language: English | 50 illus. (bw) | 157 illus. (fc)
Keywords: European Early Neolithic; LBK, settlement patterns; social organization; social conflict; village and neighbourhood structures; burial rites; enclosure; excavation report

Volume 10
Hellenistic Architecture and Human Action
A Case of Reciprocal Influence
Edited by Annette Haug & Asja Müller | 2020
ISBN: 9789088909092
Format: 210x280mm | 208 pp. | Language: English | 38 illus. (bw) | 29 illus. (fc)
Keywords: Classical archaeology; Hellenistic architecture; agency; perception

Volume 11
Interdisciplinary analysis of the cemetery Kudachurt 14
Evaluating indicators of social inequality, demography, oral health and diet during the Bronze Age key period 2200-1650 BCE in the Northern Caucasus
Katharina Fuchs | 2020
ISBN: 9789088909030
Format: 210x280mm | 406 pp. | Language: English | 25 illus. (bw) | 137 illus. (fc)
Keywords: North Caucasian archaeology; Bronze Age; burial practice; social inequality; human remains; palaeopathology; oral health; C and N stable isotopes

Volume 12
Tripolye Typo-chronology
Mega and Smaller Sites in the Sinyukha River Basin
Liudmyla Shatilo| 2021
ISBN: 9789088909511
Format: 210x280mm | 422 pp. | Language: English | 100 illus. (bw) | 90 illus. (fc)
Keywords: Prehistoric archaeology; Tripolye; chronology; mega-sites; Sinyukha River Basin; pottery; carbon dating; typochronology; Eastern Europe

Volume 13
Vom Kollektiv zum Individuum
Transformationsprozesse am Übergang vom 4. zum 3. Jahrtausend v. Chr. in der Deutschen Mittelgebirgszone
Clara Drummer| 2022
ISBN: 9789464270129
Format: 210x280mm | 343 pp. | Language: German | 53 illus. (bw) | 95 illus. (fc)
Keywords: Neolithic; Germany; Lower Mountain Range; migrations; identities; social transformations; Corded Ware; Bell Beaker; funerary archaeology; ancient DNA

Volume 14
Millet and What Else?
The Wider Context of the Adoption of Millet Cultivation in Europe
Edited by Wiebke Kirleis, Marta Dal Corso & Dragana Filipović | 2022
ISBN: 9789464270150
Format: 210x280mm | 328 pp. | Scales of Transformation 14 | Series: Scales of Transformation | Language: English | 61 illus. (bw) | 13 illus. (fc) | Keywords: archaeology; millet; Europe prehistory; Bronze Age; archaeobotany; zooarchaeology; miliacin; prehistoric agriculture

Volume 15
The Life and Journey of Neolithic Copper Objects
Transformations of the Neuenkirchen Hoard, North-East Germany (3800 BCE)
Henry Skorna | 2022
ISBN: 9789464270303
Format: 210x280mm | 198 pp. | Scales of Transformation 15 | Series: Scales of Transformation | Language: English | 50 illus. (bw) | 37 illus. (fc) | Keywords: neolithic; copper; metallurgy; hoard; isotopes; archaeometry; dagger; transformation

Volume 16.1
Unter Hügeln (Band 1)
Bronzezeitliche Transformationsprozesse in Schleswig-Holstein am Beispiel des Fundplatzes von Mang de Bargen (Bornhöved, Kr. Segeberg)
Stefanie Schaefer-Di Maida | 2023
ISBN: 9789464280487
Format: 210x280mm | 540 pp. | Scales of Transformation 16.1 | Series: Scales of Transformation | Language: German | 9 illus. (bw) | 164 illus. (fc) | Keywords: bronze age; northern Germany; funerary archaeology; chronology; burial rites; barrows; urnfields; radiocarbon dating; anthropology; palynology; archaeobotany

Volume 16.2
Unter Hügeln (Band 2)
Bronzezeitliche Transformationsprozesse in Schleswig-Holstein am Beispiel des Fundplatzes von Mang de Bargen (Bornhöved, Kr. Segeberg)
Stefanie Schaefer-Di Maida | 2023
ISBN: 9789464280517
Format: 210x280mm | 446 pp. | Scales of Transformation 16.2 | Series: Scales of Transformation | Language: German | 9 illus. (bw) | 164 illus. (fc) | Keywords: bronze age; northern Germany; funerary archaeology; chronology; burial rites; barrows; urnfields; radiocarbon dating; anthropology; palynology; archaeobotany

Volume 17
Separation, Hybridisation, and Networks
Globular Amphora sedentary pastoralists ca. 3200-2700 BCE
Johannes Müller | 2023
ISBN: 9789464270488
Format: 210x280mm | ca 396 pp. | Scales of Transformation 17 | Series: Scales of Transformation | Language: German | 38 illus. (bw) | 244 illus. (fc) | Keywords: prehistoric archaeology; pottery studies; ceramics; neolithic; globular amphorae; separation; hybridisation; connectivity; transformation

Volume 18
Mediterranean Connections
How the sea links people and transforms identities
Edited by Laura C. Schmidt, Anja Rutter, Lutz Käppel & Oliver Nakoinz | 2023
ISBN: 9789464270693
Format: 210x280mm | ca. 236 pp. | Scales of Transformation 18 | Series: Scales of Transformation | Language: English | 21 illus. (bw) | 20 illus. (fc) | Keywords: Mediterranean; transformation; connectivity; networks; seafaring; Classics; archaeology

Volume 19.1
From Ros to Prut (Volume 1)
Transformations of Trypillia settlements
Edited by Robert Hofmann, Wiebke Kirleis, Johannes Müller, Vitalii Rud, Stanislav Ţerna† & Mykhailo Videiko | 2025
ISBN: 9789464270723
Format: 210x280mm | 354 pp. | Scales of Transformation 19.1 | Series: Scales of Transformation | Language: English | 6 illus. (bw) | 151 illus. (fc) | Keywords: prehistoric archaeology; Trypillia; Chalcolithic; Mega-sites; Settlement Pattern; geophysics; geoarchaeology; archaeobotany; archeozoology; material culture; Ukraine

Volume 19.2
From Ros to Prut (Volume 2)
Transformations of Trypillia settlements
Edited by Robert Hofmann, Wiebke Kirleis, Johannes Müller, Vitalii Rud, Stanislav Ţerna† & Mykhailo Videiko | 2025
ISBN: 9789464270754
Format: 210x280mm | 450 pp. | Scales of Transformation 19.2 | Series: Scales of Transformation | Language: English | 6 illus. (bw) | 308 illus. (fc) | Keywords: prehistoric archaeology; Trypillia; Chalcolithic; Mega-sites; Settlement Pattern; geophysics; geoarchaeology; archaeobotany; archeozoology; material culture; Ukraine

From Ros to Prut:

TRANSFORMATIONS OF TRYPILLIA SETTLEMENTS

Pre-dating the urban revolution in Western Asia, a network of agricultural settlements developed in the forest-steppe zone northwest of the Black Sea in the late 5th and first half of the 4th millennium BCE, some of which are among the largest prehistoric mega-sites in Europe. These enormous so-called Trypillia/Tripolye communities are unique in many respects, and the dynamics of their formation and their development have long been a topic of intensive research. For more than ten years now, research on the transformations of these Chalcolithic societies has been conducted as a Ukrainian-Moldavian-German cooperation. This research does not only focus on some of the largest mega-sites, but also attempts to reconstruct the dynamics of mega-site processes and their economic, social and ideological foundations in different perspectives – local, regional and interregional. Although our research is not yet complete, it is already clear that the emergence of Trypillia/Tripolye mega-sites represented the preliminary culmination of a regionally differentiated and widely interconnected process of settlement formation in the area between the Prut and Ros rivers. These processes were, on the one hand, closely interwoven with Copper Age societies of Southeast Europe and, on the other hand, ushered in the transition to the era characterised by higher settlement mobility.

This volume brings together archaeological, geophysical, archaeobotanical, archaeozoological and geoarchaeological contributions on economy, settlement patterns, material culture and dating from three different test regions in the territory of present-day Ukraine and Moldova. The presentation of our new data contributes decisively to a better understanding of both the enormous variability of settlement trajectories characterising this vast area and to connecting developments throughout time.

Volume 2 contains contributions on the interfluves of the Southern Bug and Dniester, and the Dniester and Prut. Additionally, it provides regionally overarching insights.

CRC 1266
SCALES OF TRANSFORMATION

sidestonepress
ISBN: 978-94-6427-075-4