The Iron Age Settlements in the Micro-Region of Horodişte-Ţipova, Distr. Rezina, Republic of Moldova. Magnetic Prospection, UAV Images and Drillings

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Mots-clés : *âge du Fer / Carpates orientales / Dniestr moyen / géophysique / échantillons de sol / imagerie par drone (UAV)*

Introduction

The territory of the present-day Republic of Moldova as the westernmost part of the Eurasian steppe and forest-steppe has always been a zone of transition between the Central European regions of the Carpathians, the Carpathian Basin and the plains of Eastern Europe, both in prehistoric and historical times. Thus, from the 12th to the mid-7th century BC the Eastern Carpathian area was influenced by the so-called "Hallstattization" process that is closely related to the Middle Danube region (Кашуба 2012). From the second half of the 7th century BC the vector of that cultural impact changes to the East, to the steppes north of the Black Sea, where eastern nomads, primarily the so called 'Scythians', begin to dominate (Бруяко 2005)[1]. At the same time, in the second half of the 7th and the 6th centuries BC, several Greek colonies were established on the northern and northwestern coast of the Black Sea, which also contributed to the development of both sedentary 'Getic' and nomadic 'Scythian' communities (Banari 2003).

This paper is divided into three main parts. At first we describe the Eastern Carpathian region from an archaeological perspective. This is followed by the presentation of the Horodişte-Ţipova micro-region and the site-focused investigations of 2019. In addition to explaining the local geography, the history and status of research, and the magnetic survey, this part includes the interpretation of aerial photography, photogrammetry, drillings and the chemical soil analysis. The third section presents our interpretations of the data and an overview of planned and upcoming investigations.

Our project is a binational research project, with the participation of Moldova State University (Chişinău), Thuringian State Office of Heritage Management,

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[1] Terms such as Scythians or Getae are understood as cultural terminology here and are not used in the sense of ethnic classification. The vocabulary is strongly rooted in the local archaeological community as well as in the literature, so that the use of these terms could not be avoided in some passages.

Friedrich-Schiller-University of Jena and the Römisch-Germanische Kommission (RGK) of the German Archaeological Institute. The research conducted by the RGK is embedded in an international project on large-scale settlements of the Iron Age and their socio-economic environment (https://publications.dainst.org/journals/ejb/article/view/2421/7028 [p. 113; last access: 6.10.2022]).

The Eastern Carpathian region – preliminary remarks

For the first millennium BC, several interrelated archaeological cultures have been defined for the Eastern Carpathian region, which can be assigned predominantly to sedentary communities in the forest-steppe region and nomads in the steppe *(fig. 1)*. The size of the population of the region may have varied from period to period. Currently, based on the results of archaeological investigations, we can identify two periods of demographic growth. The first period occurred in the 10th–9th centuries BC, when the Cozia-Saharna culture spread from the area between the Siret and the Dniester into the forest-steppe region (Hänsel 1976, 134; László 1989, 111–129; Мелюкова 1989, 20–23; Кашуба 2000, 241–488).

To date, 13 fortifications, over 120 open settlements and nine necropolises have been documented in the area of this culture, which occupies parts of the current territories of the Republic of Moldova and Eastern Romania (Кашуба 2000, 241–488; Zanoci / Băţ 2011). Most sites of the Cozia-Saharna culture are concentrated in the area between the Siret and Prut rivers, as well as in the Middle Dniester region. Thus, in the western cultural area, fortifications at Brad (Ursachi 1995, 22; 99), Răcătău (Căpitanu 1997) and Pocreaca (Iconomu 1996), as well as many open settlements, have been documented – Cozia, Horpaz, Ţibăneşti and others (László 1972, 207–224; László 1994, 168–184). However, in terms of the degree of study and the number of sites attributed to this culture, the southern part of the Middle Dniester region stands out, where at present 9 fortifications, 43 open settlements and nine necropolises are known *(fig. 2;* Мелюкова 1989, 20–23; Кашуба 2000; Niculiţă / Zanoci / Băţ 2016).

The second phase of population growth took place in the 5th/4th–3rd centuries BC and is associated with the so called 'Getic' culture. Currently, about 120 fortifications, over 300 open settlements and about 20 necropolises and isolated graves are known in the area of this culture (Zanoci 1998; Teodor 1999; Arnăut 2003; Haheu 2008). The sites are not evenly distributed in the Eastern Carpathian space. Instead, they are mainly concentrated in the plateau regions (Central Moldavian Plateau, Suceava Plateau, Dniester Plateau, etc.), near rivers or other aquatic sources. For example, on the Central Moldavian Plateau a number of fortifications, including Bunești, Moşna, Arsura, Răducăneni have been researched, and several open settlements found nearby (Berzovan 2019). A similar situation is known from the Suceava Plateau region, where the fortifications of Stânceşti (Florescu / Florescu 2005), Cotu-Copălău (Şovan / Ignat 2005), Cotnari-Cătălina (Berzovan 2018), and others have been investigated, each being also accompanied by several open settlements. Another "agglomeration" of sites attributed to the culture has been investigated along the lower course of the Răut River, where 10 fortifications – Butuceni, Trebujeni "Potârca", Măşcăuţi and others – and 18 open settlements have been identified (Niculiţă / Teodor / Zanoci 2002; Zanoci 2004; Niculiţă / Matveev / Nicic 2019). However, most sites attributed to the 'Getic' culture are currently known from the southern part of the Middle Dniester region, where there are 39 fortifications and 58 open settlements *(fig. 3)* (Kašuba / Haheu / Levițki 2000, 119–125; Niculiţă / Zanoci / Băţ 2016; Zanoci / Niculiţă / Băţ 2019).

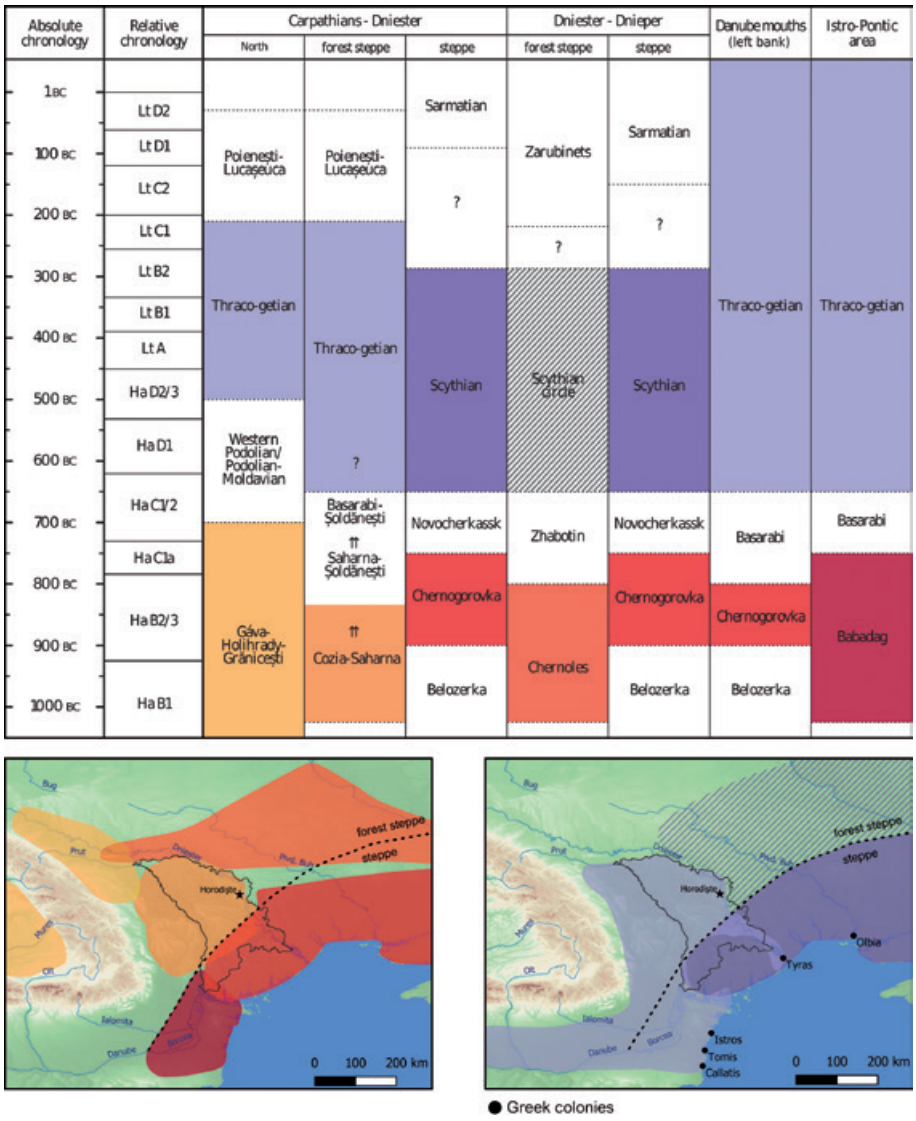
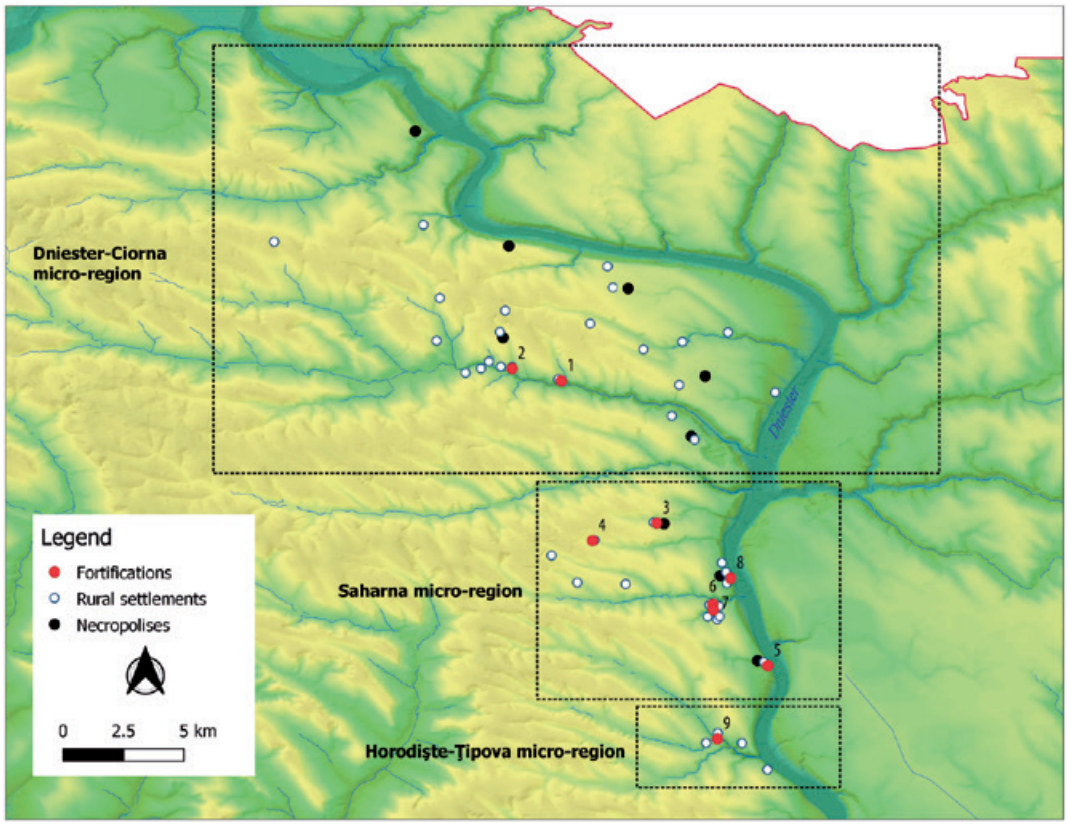
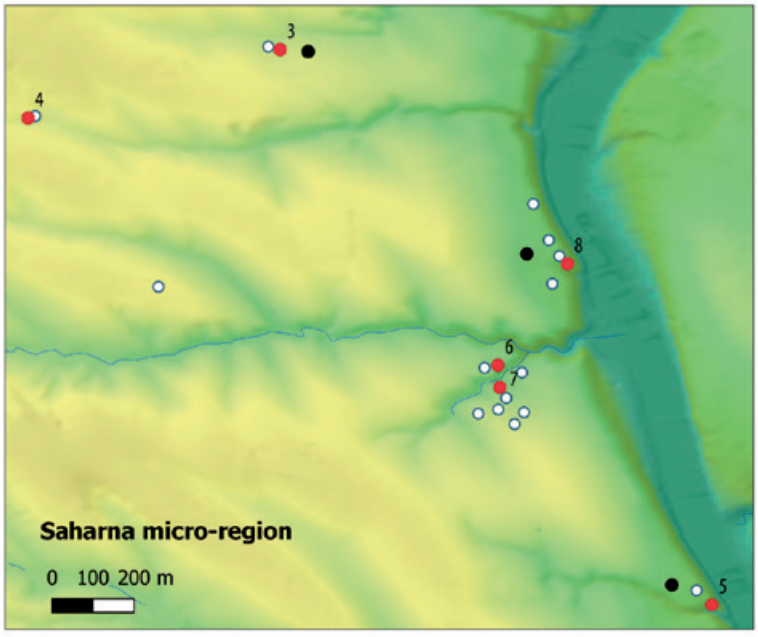


Fig. 1. Overview on the chronology and archaeological cultures in the 1st millennium BC in the area west and north of the Black Sea (images by A. Zanoci and M. Kohle after Vulpe / Petrescu-Dîmboviţa / László 2001 fig. 50; Zirra 2017 fig. 4 g; Алексеев 2003 таб. 1; Кашуба 2012 рис. 6)

The mapping of the sites shows that they are not evenly distributed across the Middle Dniester area – usually they are grouped in clusters consisting of several hillforts and a variable number of open settlements. Such "agglomerations" can now be identified in the Dniester-Ciorna micro-region, the Saharna micro-region and in the Horodişte-Ţipova micro-region (Zanoci / Niculiţă / Băţ 2019, 315–321).

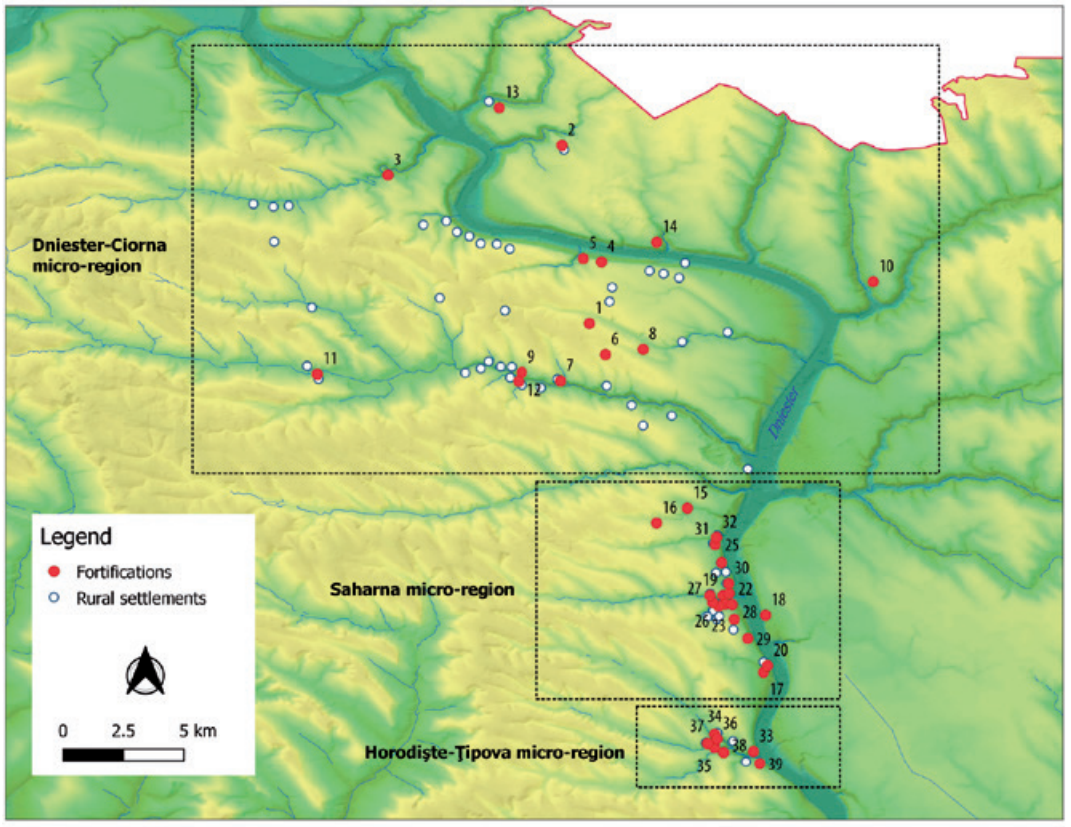
In the Middle Dniester region, settlements from the Bronze Age, e. g. of the Noua culture, are missing. The same is true of the subsequent Poienești-Lucașeuca culture. With the exception of some isolated discoveries (Лапушнян / Никулицэ / Романовская 1974, 79), no sites have been discovered to date (Iarmulschi 2020 fig. 2). This leads to

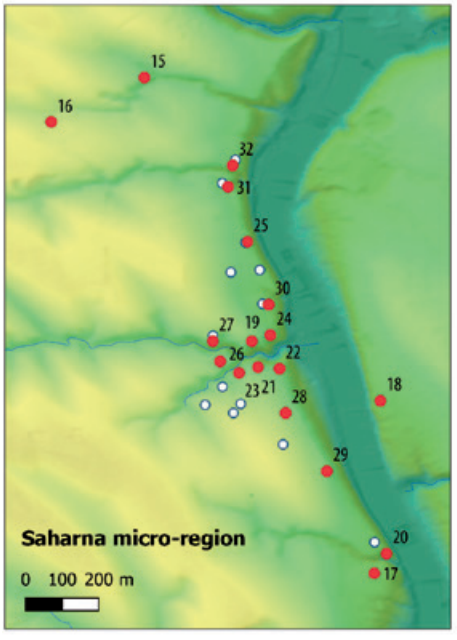




Fortifications	
1.	Glinjeni „La Şanţ"
2.	Mihuleni IX
3.	Ţareuca
4.	Ţahnăuţi
5.	Saharna „Hulboaca"
6.	Saharna Mare
7.	Saharna „Rude"
8.	Saharna-Ţiglău „Cetăţuie"
9.	Horodişte „La Şanţ"

Fig. 2. Sites of the 10th/9th century BC in the Middle Dniester area (image: A. Zanoci and M. Băţ).





Fortifications			
1.	Alcedar „La Cordon"	20.	Saharna „Hulboaca"
2.	Caterinovca	21.	Saharna „La Şanţ I"
3.	Climăuţii de Jos	22.	Saharna „La Şanţ II"
4.	Curătura	23.	Saharna „La Şanţ"
5.	Curătura IV	24.	Saharna „La Vile"
6.	Glinjeni „La Lacuri"	25.	Saharna „Revechin"
7.	Glinjeni „La Şanţ"	26.	Saharna Mare
8.	Mateuţi „La Şanţuri"	27.	Saharna Mică
9.	Mihuleni X	28.	Saharna Nouă III
10.	Molochişul Mare	29.	Saharna Nouă V
11.	Olişcani „Roata Turcilor"	30.	Saharna-Ţiglău „Cetate"
12.	Parcani „Zanova"	31.	Stohnaia III
13.	Raşcov	32.	Stohnaia IV
14.	Stroieşti	33.	Buciuşca II
15.	Rezina	34.	Buciuşca III
16.	Ţareuca	35.	Horodişte „La Cot"
17.	Buciuşca	36.	Horodişte „La Şanţ"
18.	Ofatinţi	37.	Horodişte II
19.	Saharna „Dealul Grimidon"	38.	Ţipova III
		39.	Ţipova IV

Fig. 3. Sites of the 4th/3rd century BC in the Middle Dniester area (image: A. Zanoci and M. Băţ).

the conclusion that during the Iron Age a particular set of features made large settlements like Horodişte-Ţipova or the Saharna agglomeration vulnerable (e. g. Adger 2000, 348; Fletcher 2007, fig. 7,8 and summarized 187; Fletcher 2009, 7 f.). The question is, which of these features can we reconstruct today, how did they condition one another and how did they interplay? As a central thesis, we can assume that not just one process led to the significant increase of settlements and fortifications. Rather, there were different phenomena such as climate change, social and spatial dynamics, political formations or population growth that partly depend on each other (Fletcher 2007, 36 f.; Schreg 2014, 301 f.; Nakoinz / Knitter 2016, 13; Meier 2020, 18; 25; 31).

The processes may have included not only different kinds of interaction but also spatial and social mobility, which in turn may have led to conflicts, as the development of fortifications played an increasingly dominant role in the life of the communities in the Eastern Carpathian region. Furthermore, open settlements as well as fortifications must be understood in the context of their environment. For now we can only assume that large settlements and their satellites developed at this point as a result of the processes mentioned above and the favourable local topography. At Horodişte-Ţipova, there was a viable river crossing which required supervision by a local community.

Currently, the Saharna micro-region is the best-known archaeological area. In the past two decades, surveys and extensive excavations were carried out, and the results of these investigations published in two monographs (Niculiţă / Zanoci / Arnăut 2008; Niculiţă / Zanoci / Băţ 2016) and several articles (e. g. Niculiţă et al. 2019; Băţ / Simalcsik / Zanoci 2019; Zanoci / Băţ 2020; Zanoci et al. 2020b). Archaeological research was also conducted at several sites in the Dniester-Ciorna micro-region (c. f. e. g. Гольцева / Кашуба 1995; Kašuba / Haheu / Leviţki 2000; Zanoci / Niculiţă / Băţ 2017). Only the Horodişte-Ţipova micro-region has hardly been explored, a desideratum that offers solid prospects for our future investigations.

In particular, the insights gained from the magnetometric surveys and excavations at Saharna, briefly summarized below, served as a starting point and reference for our research. These insights are of outstanding importance for the interpretation of the measurements in Horodişte. The excavations at Saharna revealed a number of pit features and house remains that, judging by the shape of anomalies and the dynamics of their magnetic values, are also to be expected to be of a similar form in Horodişte.

The southern part of the Middle Dniester region shows a particular density of archaeological sites, dating to both the 10th–9th and the 5th/4th–3rd centuries BC. Nine fortifications, 43 open settlements and nine necropolises from the Early Iron Age *(fig. 2)* are known there (Кашуба 2000; Niculiţă / Zanoci / Băţ 2016). 39 fortifications and 58 open settlements are attributed to the second period of the Iron Age *(fig. 3)* (Kašuba / Haheu / Leviţki 2000, 119–125; Niculiţă / Zanoci / Băţ 2016; Zanoci / Niculiţă / Băţ 2019).

The Horodişte-Ţipova Micro-Region

Natural Environment and Geography

The Horodişte-Ţipova micro-region covers an area of about 6 km^2 and is located in the Southern Middle Dniester basin. The region is part of the westernmost edge of the Eurasian forest steppe belt, and the site is situated on the right bank of the river in the central-eastern extremity of the Dniester Plateau. The absolute altitude of the territory varies from 26 m in the Dniester riverbed to 234.5 m on the hill on the outskirts of Ţipova

Forest. The foundation of the territory consists of limestone deposits of the middle Bessarabian, the so called 'Sarmatian' sub-stage, which form outcrops in the river valleys and in the eastern parts of the Pliocene terraces of the Dniester River. Towards the western periphery of the micro-region, the foundation consists of clay-sand deposits from the same period (Вовос 2007, 47–48). The territory is segmented by a network of deep gorges, with steep slopes (up to 100–150 m) formed by the tributaries on the right bank of the Dniester. The main tributary is the Jidauca (also called Ţipova in some sources), into the right bank of which the small rivers of Valea Satului (Horodiştei) and Blănăriţa run, while an intermittent stream runs to the west of the village of Ţipova (*fig. 4a* and *b*). In their lower courses these rivers run through narrow valleys practically devoid of floodplains, forming occasional waterfalls and rapids, and there are caves and grottoes covered by petrophyte vegetation in the rocky slopes. In the interfluves of Valea Satului (Horodiştei), Jidauca, and Blănăriţa a plateau was formed with very steep slopes and two promontories at the northern and southeastern extremities. Protection by steep natural slopes on three sides offered favourable defensive conditions for the inhabitants. The climatic conditions of the Horodişte-Ţipova micro-region are favourable for human life and activity, as there is also a varied range of natural resources for humans: drinking water (from rivers, springs and underground sources), vegetation (forests, meadows, etc.) and wildlife (including hunting and fishing), fertile soils (predominantly chernozem) and abundant building materials (wood, limestone, clays, sands).

History and State of Research

The first archaeological investigations in the Horodişte-Ţipova micro-region date back to the second half of the 1940s and are related to the activities of Gheorghii D. Smirnov (1946) and Tatiana S. Passek (1947). Their work identified two fortifications which, although spatially separated, were both given the same name: Horodişte. The one discovered and described by G. D. Smirnov, now known as Horodişte "La Şanţ"[2], was attributed to the so called 'Scythians'[3] (Смирнов 1949a, 196). The other site (Horodişte II), based on surface finds, was considered to be inhabited initially by bearers of the Trypillia Culture and later by the Scythians (Пассек 1949, 64).

In 1967, non-invasive surveys near the village of Horodişte were undertaken by Vera N. Verina, who found a settlement (Horodişte "Groapa Turcului") belonging to the Early Iron Age (10th–9th century BC) (Лапушнян / Никулицэ / Романовская 1974, 18).

In 1992, near the village of Ţipova, Oleg Leviţki carried out surface surveys, which revealed the settlement of Ţipova II, also belonging to the first period of the Iron Age (Leviţki 1993, 10).

In 2013, in order to verify the previous information as well as to identify new sites, the team of the "Thracology" Scientific Laboratory of the Moldova State University undertook

[2] The toponym "La Şanţ" was used for the first time by Ion Hîncu, as a result of the surface investigations he carried out at the fortress of Horodişte in 1980 (Хынку 1987, 45).

[3] In Soviet historiography, until the end of the 1950s, all archaeological sites from the 4th–3rd century BC in the Prut-Dniester area were assigned to the 'Scythians'. Only after the publication by Anna I. Melyukova (Мелюкова 1954, 68; Мелюкова 1955, 70; Мелюкова 1958, 99–102) this hypothesis was revised, and it became obvious that the archaeological materials found in this region resembled those from the area west of the Prut and those in the lower reaches of the Danube, which are attributed to the 'Getic' communities.

a

b

Fig. 4. Impression of the river valleys around the plateau (photos: a) D. Scherf and b) A. Zanoci).

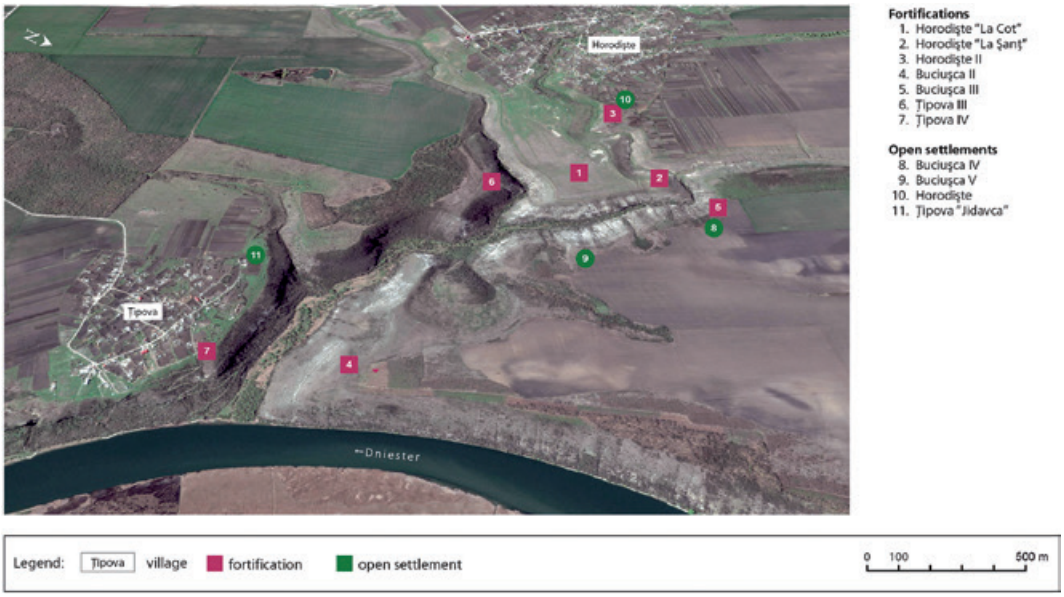


Fig. 5. Sites in the Horodişte-Ţipova micro-region (image: A. Zanoci and M. Băţ).

No.	Site name	Early Iron Age 10th–9th century BC	Late Iron Age 4th–3rd century BC
1	Horodişte "La Cot"		fortification
2	Horodişte „La Şanţ"	fortification	fortification
3	Horodişte II		fortification
4	Buciuşca II		fortification
5	Buciuşca III		fortification
6	Ţipova III		fortification
7	Ţipova IV		fortification
8	Buciuşca IV	unfortified settlement	unfortified settlement
9	Buciuşca V		unfortified settlement
10	Horodişte	unfortified settlement	unfortified settlement
11	Horodişte "Groapa Turcului"	unfortified settlement	
12	Ţipova II	unfortified settlement	
13	Ţipova "Jidavca"		unfortified settlement

Tab. 1. Chronology of sites in the Horodişte-Ţipova micro-region (A. Zanoci and M. Băţ).

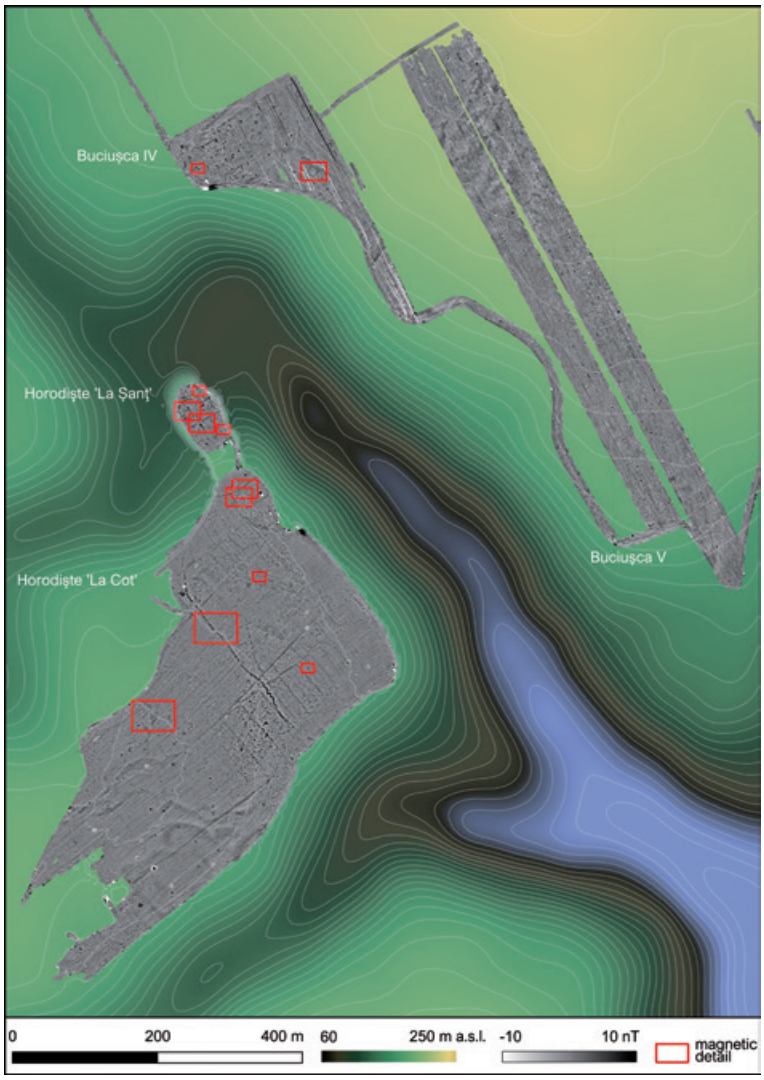


Fig. 6a. Horodişte-Ţipova – Overview of the magnetic prospection of the Horodişte-Ţipova micro-region; showing the position and extent of the magnetic details in *figures 10–14.17* (map: M. Kohle).

surface investigations in the Horodişte-Ţipova micro-region (Zanoci / Niculiţă / Băţ 2015, 81–100). As a result, in addition to the two previously known fortifications and the two open settlements, five hillforts of various size and four open settlements were also discovered. Thus, the number of archaeological sites from the Iron Age in this region had risen to 13.

Among them, the "La Şanţ" and "La Cot" fortifications near the village of Horodişte, which stand out due to their strategic position and degree of conservation, were surveyed. In Horodişte "La Şanţ" the investigations were carried out over an area of 20 m^2 in the central part of the fortification. The artifacts allowed for the identification of two settlement phases at this site: during the 10^{th}–9^{th} centuries BC (the Cozia-Saharna culture) and the 4^{th}–3^{rd} centuries BC (the Getic culture) (Niculiţă / Zanoci / Băţ 2014, 241–243

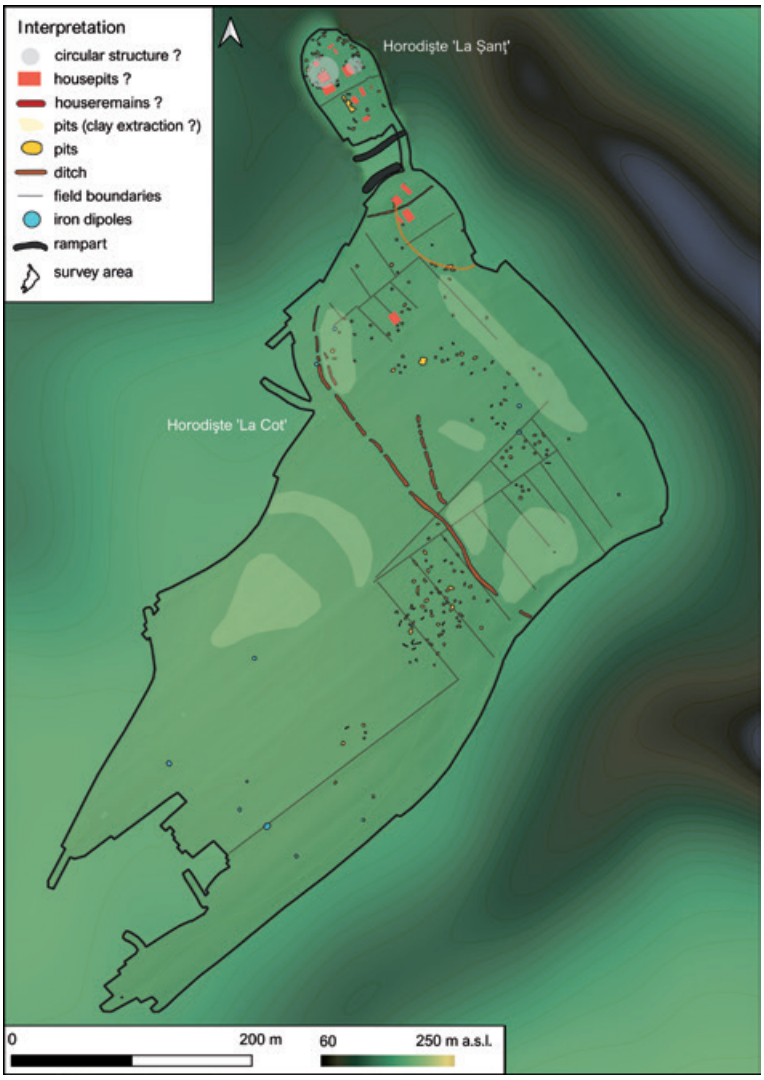


Fig. 6b. Horodişte-Ţipova – Interpretation of the magnetic prospection 2019 (map: M. Kohle).

figs 7–12; Zanoci / Niculiţă / Băţ 2015, 89–91 figs 9–10). At Horodişte "La Cot", a trench with an area of 28 m^2 was opened at the southeast edge of the fortification, where the traces of a defensive construction were visible. As a result of the investigations, it was confirmed that on this side of the site a "wall" of wood, earth and stone was built, about 1.0–1.2 m wide. The construction could be dated on the evidence of the collected archaeological material to the 4th–3rd centuries BC (Niculiţă / Zanoci / Băţ 2014, 236–237 fig. 3; Zanoci / Niculiţă / Băţ 2015, 86–87 fig. 6).

Based on the surface finds and the artefacts recovered during the small trial excavations, it is currently possible to distinguish two habitation phases in the Horodişte-Ţipova micro-region in the Iron Age. For each of them there are characteristic "agglomerations" composed of fortifications and open settlements. In the first phase, dated to the 10th–9th

centuries BC (Cozia-Saharna culture), there was one fortification and three open settlements. In the second phase, dated to the 4th–3rd century BC, seven fortifications and four open settlements[4] (*fig. 5* and *tab. 1*). For the period between these phases, given the current state of our research we must assume there was a hiatus.

Within the micro-region of Horodişte-Ţipova the fortified hilltop settlement of Horodişte was of major importance. The settlement is divided into a small settlement core, "La Şanţ", of 0.6 ha situated on a promontory, and the outer settlement of "La Cot". The outer settlement is located on an extensive plateau and its size was once estimated at 28 ha, based on the assumption that it encompasses the entire area. The current project aims to understand the fortified settlement in the context of the surrounding settlement landscape. For this purpose, it is necessary to also consider the unfortified settlements around "La Şanţ" and "La Cot".

The survey carried out in October 2019 was designed to address this, and extensive prospections were carried out at the fortified settlements "La Şanţ" and "La Cot", as well as at the satellite settlements of Buciuşca IV and V.

Magnetic Prospection

The magnetic prospection was carried out on October 25th and 26th, 2019. A SENSYS 14-channel system (Magneto MX-14-channel system) with a sensor distance of 25 cm was used for the high-resolution measurements. The positioning data was recorded with a DGPS (Leica 1200). The base station was implemented on the rampart of "La Şanţ", and the reference point was marked with a steel pipe (WGS84 N 47.618024, E 28.960674). A quad ATV Kawasaki KVF400 Prairie (15.7 kW) was used as the towing vehicle.

The prospected area is currently used as pasture land. Disadvantages were overgrown depressions or pits in the ground. In some areas, the plateau was used as a waste disposal site and quarry. In addition to the heavily disturbed area to the southeast, there are other areas of varying intensity of disturbance on the plateau. The measured area of 0.6 ha of "La Şanţ" and 15 ha of the outer area of "La Cot" provide basic information for estimations of building density and use *(fig. 6)*.

"La Şanţ"

The terrain of "La Şanţ" is the core area of the fortified settlement and is separated by two ramparts from the "La Cot" plateau. The outer rampart is of about 15 m width at the base and currently still about 2.3 m high. The inner one is a little lower, with a height of approximately 1.5 m and a width of 10 m at the base *(fig. 7)*. The magnetically surveyed area reached right up to the inner rampart. Close to the inner side of the inner rampart, a linear structure with low magnetic contrast is detectable (*figs 6* and *7*). This structure might be interpreted as an erosion gully. Two linear structures are clearly visible in the UAV-image based DEM *(fig. 7)* as well as in the magnetic data (*figs 6* and *8b,2*). One of them, crossing the spur from southwest to northeast, is a rampart which was trial-excavated in 2013 (Zanoci / Niculiţă / Băţ 2015). The other one may be a recent field boundary. Relatively common are pit-like anomalies, which are often to be found in the settlements. Some of the anomalies of irregular, partly amoeboid shape might be interpreted as accumulations

[4] For information on the organization of the defense system in the Horodişte-Ţipova micro-region, see also: Zanoci / Băţ 2017, 7–10 figs 5 and 20; Zanoci / Niculiţă / Băţ 2019, 320–321 figs 7 and 9.

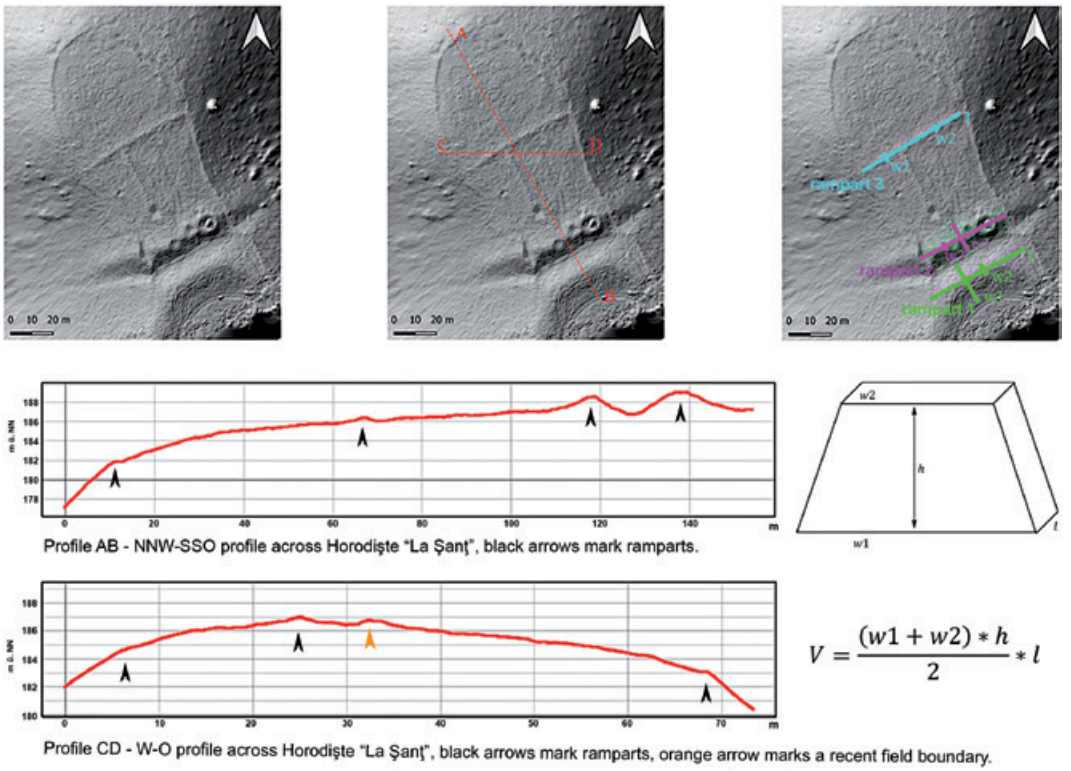


Fig. 7. UAV based DEM of "La Şanţ" showing the preservation of the ramparts between "La Cot" and "La Şanţ" (D. Scherf and Riko Süssenguth).

of daub from houses marking former house locations *(fig. 9)*. Besides these indications for houses, another structure is marked by a linear anomaly of 0.6 m width that encloses a rectangle of about 7 × 12 m *(fig. 8a,1)*. These are probably remnants of the base of a house wall. Inside the house area, a circular dipole with values up to a maximum of 12 nT and a diameter of 1 m might indicate a contamination from recent times. An interpretation as a pit is less likely *(fig. 8a,1: profile C–D)*. Outside the house area, in its northern neighbourhood, a circular anomaly indicates a settlement pit with a diameter of ca. 3 m *(fig. 8a,1: profile A–B)*. The numerous pits on "La Şanţ" are of different size and have differing layers of fill. Anomalies with values of up to 6–12 nT might indicate refilling with burnt material such as house daub *(fig. 8c,5)*, whereas another one, with lower values of max. 2–3 nT, indicates a structure refilled with low magnetic settlement remains *(fig. 8c,6)*.

Outside the outer rampart a linear anomaly, probably a ditch, separates the inner settlement "La Şanţ" from the plateau "La Cot" *(fig. 6)*. The curved course of the structure suggests a connection with the ramparts of "La Şanţ" rather than an interpretation as a field boundary. The trench-like structure is about 2 m wide. The low values of max. 4 nT indicate filling with sediments from the settlement or sediments from the direct vicinity *(fig. 8b,3)*. The low nT-values likewise indicate the absence of burnt material such as house debris or the remains of a rampart damaged by fire.

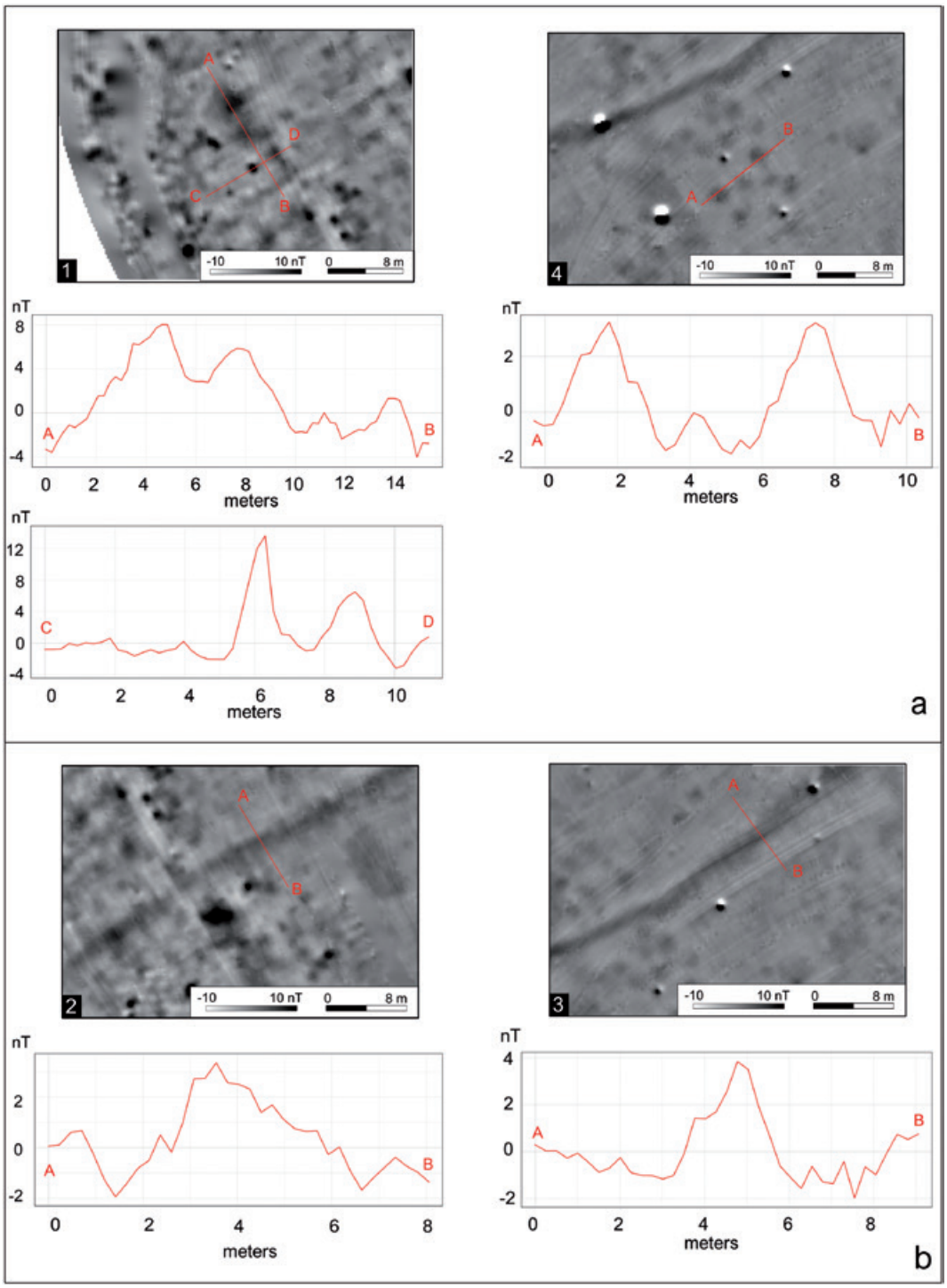


Fig. 8. Magnetic maps and sections through (a) possible house remains (1; 4), (b) the structure dividing the spur, probably a field boundary (2) and the ditch separating the spur “La Şanţ” from the plateau “La Cot” (3), (c) pits on the plateau "La Cot" (5 and 6) (map: M. Kohle).

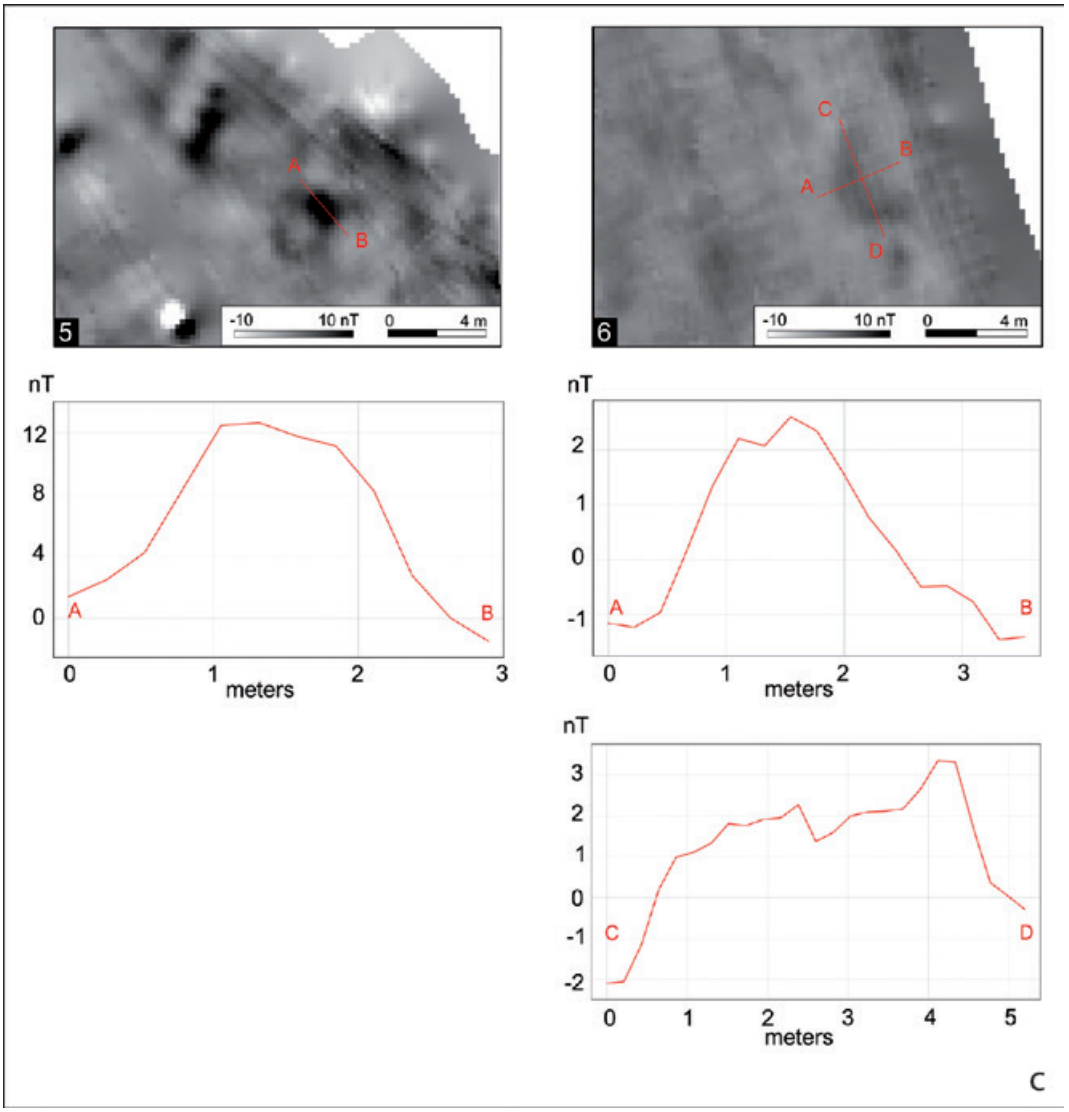


Fig. 8. cont.

"La Cot"

It was previously assumed that the entire plateau "La Cot" in front of the spur "La Şanţ" was part of the Iron Age settlement. The magnetic prospection revealed traces of a ditch which crosses the entire plateau and defines a smaller settlement area of about 6 ha *(fig. 6)*. This means that only about one third of the plateau was part of the settlement and the function of the ramparts on the edges of the plateau, which enclose a substantially wider area, is currently not understood. The trench signature is not continuous but shows some gaps, which could be interpreted as passages / gates *(fig. 10)*.

The density of anomalies indicating settlement activities is much lower on "La Cot" than on "La Şanţ". These are mainly pit-like anomalies, probably settlement pits. The

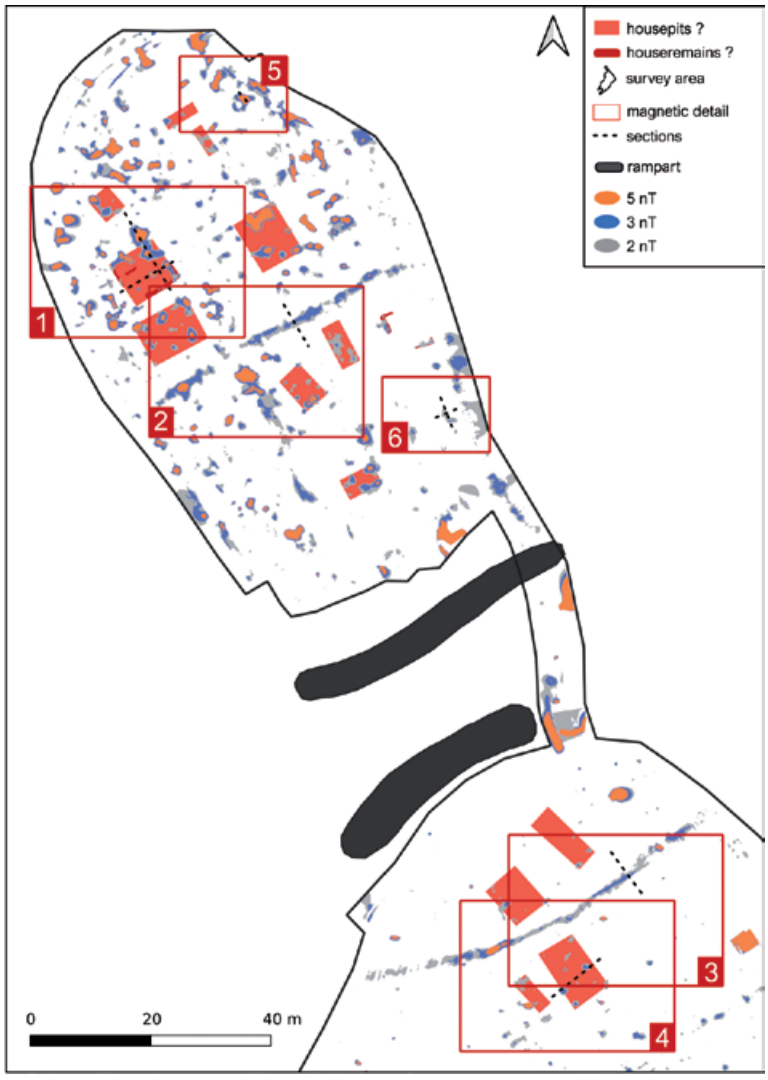


Fig. 9. Contour map and interpretation of anomalies on the spur „La Şanţ“ with the location of magnetic detail maps and sections through possible house remains (1 and 4), the structure dividing the spur, probably a field boundary (2), the ditch separating „La Şanţ“ from the plateau (3) and pits (5 and 6) (map: M. Kohle).

contrast, with values of up to 5 nT, is clear enough but argues against the presence of burnt remains or clay. Their diameters vary between 1.5–2.5 m *(fig. 11)*.

Clearer evidence of house sites is only visible in small numbers *(fig. 9,4)*. A cluster of small circular anomalies in a regular arrangement could be the remains of post holes of a building with an area of 7×12 m. The post holes have a diameter of ca. 0.8 m. The magnetic values are a little above 2 nT (*fig. 8a,4: profile A–B)*.

Outside the area enclosed by the trench on the “La Cot” plateau, another single cluster of pits can be identified in the magnetic data *(fig. 10a,4)*. The size of the cluster is also about 1.2 ha. There are numerous anomalies with high magnetic values above 10 nT *(fig. 12)*, some of which are related to the field boundaries and might be waste from recent

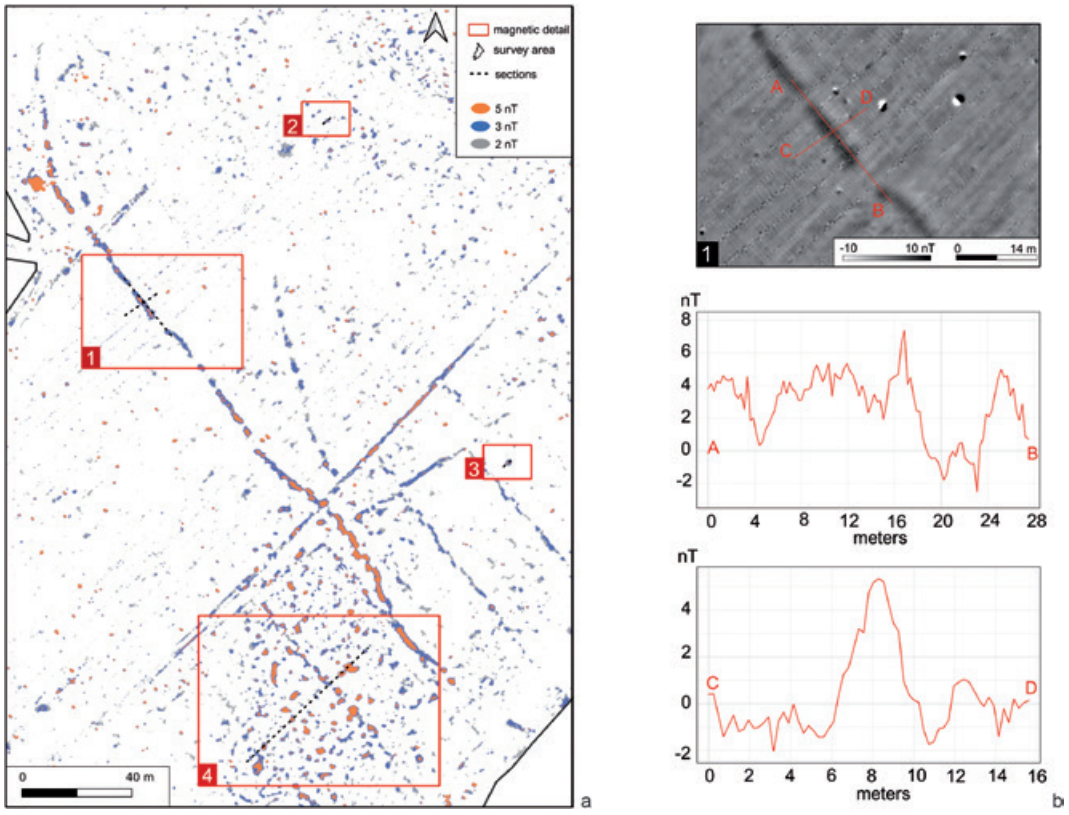


Fig. 10. "La Cot" a) Contour map of anomalies on the plateau with the location of magnetic detail maps and sections through the outer ditch (1), pits (2–3) and structures indicating settlement activity (4). b) Magnetic map and sections through the outer ditch (map: M. Kohle).

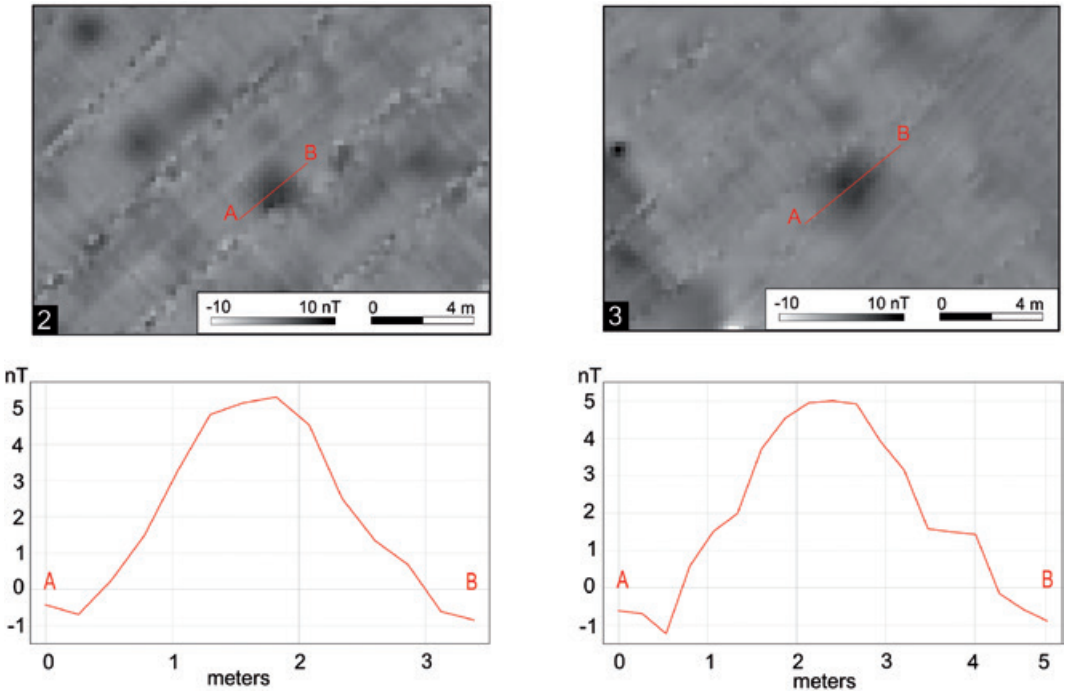


Fig. 11. Magnetic maps and sections through two pits on the plateau "La Cot" (map: M. Kohle).

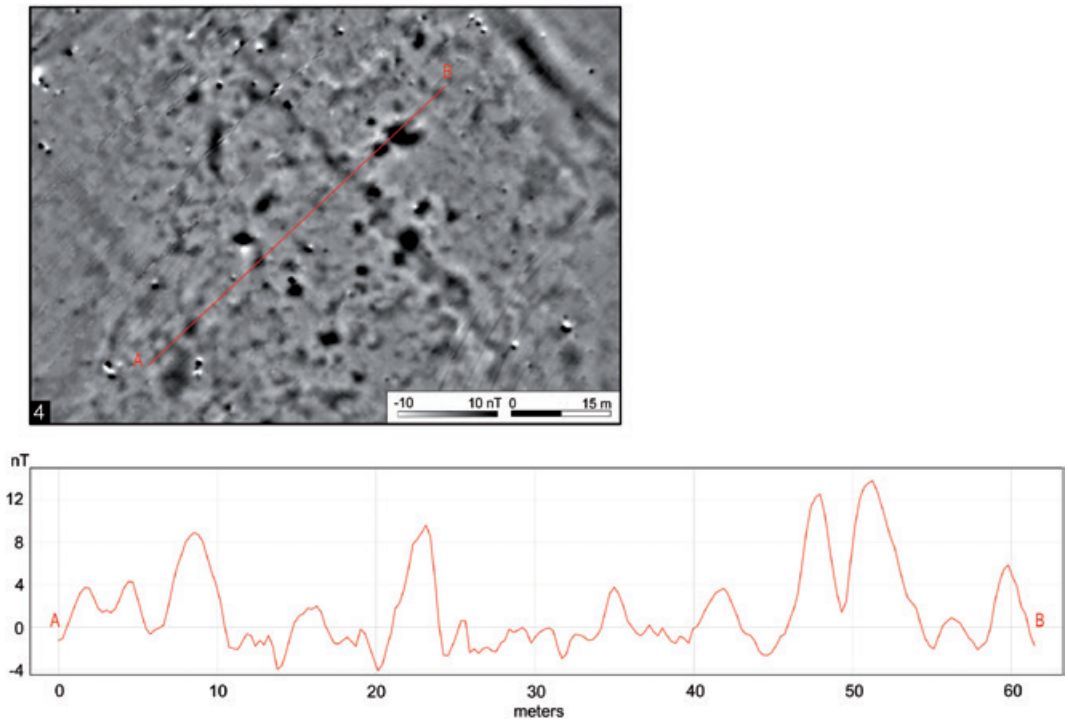


Fig. 12. Magnetic map and section through structures indicating settlement activity outside of the ditch on the plateau "La Cot" (map: M. Kohle).

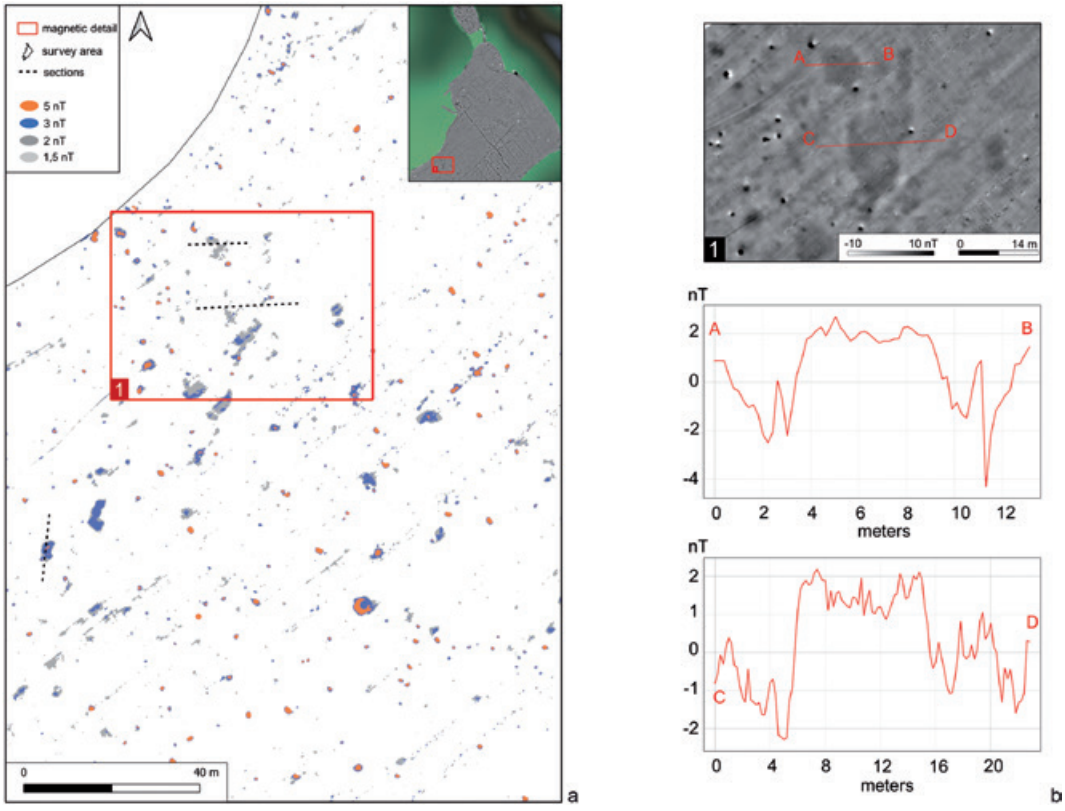


Fig. 13. "La Cot" a) Contour map of anomalies on the plateau outside of the outer ditch with the location of b) magnetic map (1) and sections through pits (possible clay extraction) (map: M. Kohle).

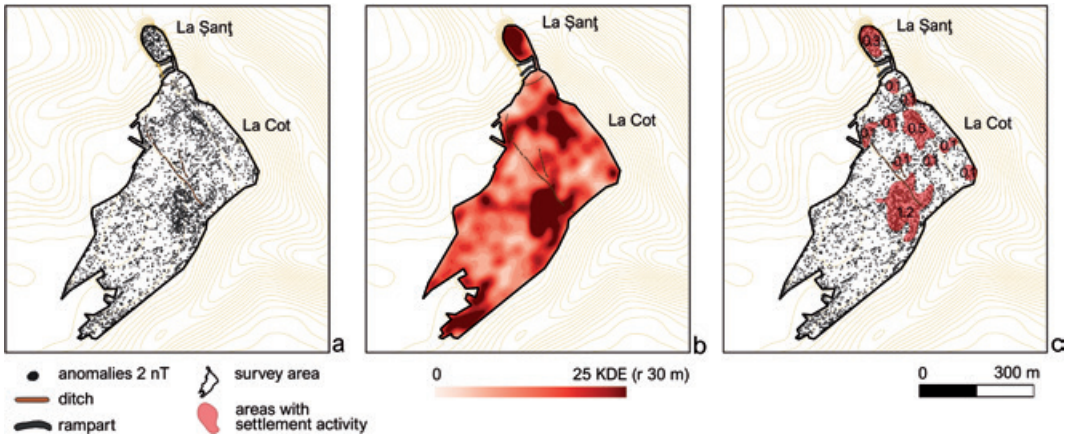


Fig. 14. Horodişte "La Şanţ", "La Cot". a) Map showing polygons of selected anomalies (2 nT and 0.5–10 m²) which were used to process a KDE (r 30 m) (b). c) Combination of the former results showing areas with higher settlement activities (map: K. Rassmann).

times. But most of the anomalies could be accumulations of house debris related to the Iron Age settlement activities.

In addition to the relatively high-contrast pit anomalies, low-contrast structures are visible. The structures are extensive, sometimes more than 20 m in length and of irregular outline. The magnetic contrast is low, the values amount to a maximum of 2 nT *(fig. 13)*. The features could be interpreted as pits for clay extraction. The dating is unclear.

Summary: "La Şanţ" and "La Cot"

To estimate the settlement activities on "La Şanţ" and "La Cot", based on the magnetic raster map polygons with 2 nT were selected and used to process a Kernel Density Estimation (KDE). For this we selected polygons larger than 0.5 m² and smaller than 10 m² *(fig. 14a)*. The boundaries for the selection are based on empirical observations of the data to select possible settlement pits and accumulations of house debris. Based on the polygons, centroids were calculated and used for the KDE *(fig. 14b)*.

The estimation highlights areas related to higher settlement activities. These areas can be used to approximate the spatial structure of Iron Age settlements. It must be taken into account that a temporal differentiation of the anomalies is not possible and that this model is only hypothetical.

Based on the KDE, the settlement cluster on "La Şanţ" with an area of 0.3 ha, and 10 areas of different size within the plateau enclosed by the ditch on "La Cot" are striking. The small size of 0.1 ha for most of the areas could be explained by their being individual house sites, while the largest area of 0.5 ha in the central part stands out as a cluster of several houses *(fig. 14c)*.

Outside the site, in the immediate vicinity of the ditch, an area of 1.2 ha shows a closed accumulation of settlement activities *(fig. 14c)*. It is not clear whether there is a chronological connection with the settlement within the area enclosed by the ditch.

In general, the density of archaeological anomalies is much higher in the core area of "La Şanţ" than on the plateau "La Cot". This observation probably suggests more intensive use

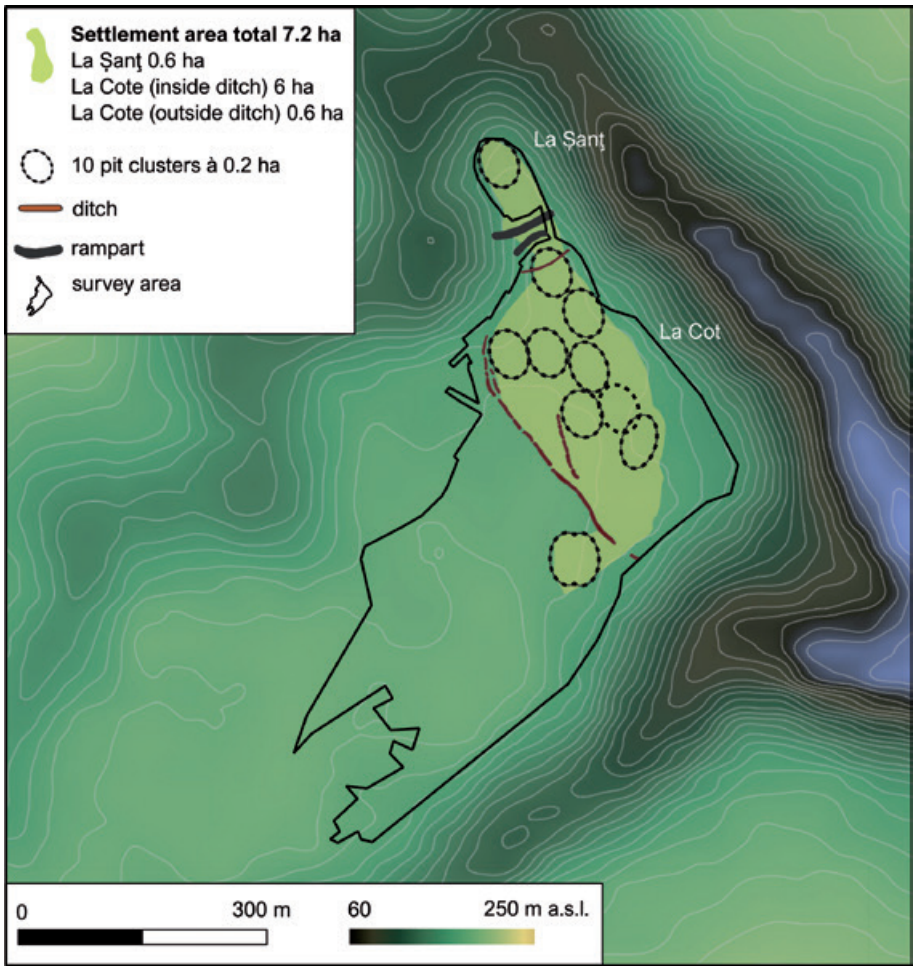


Fig. 15. Horodişte "La Şanţ", "La Cot". Interpretation of the density map (map: K. Rassmann and M. Kohle).

and also a longer duration of the settlement. The latter is discussed below in the context of soil chemical analyses.

To summarize the results of the prospection at "La Şanţ" and "La Cot", it can be assumed that one group is present in the core of the site "La Şanţ", 5–10 in the area of the fortified plateau of "La Cot", and another one in the periphery *(fig. 15)*. This assumption requires clarification by excavations, as does the chronology of the settlement groups.

Sites Buciuşca IV and V

Opposite the "La Cot" plateau there is a small Iron Age settlement site of about 1 ha in size (Buciuşca IV). Magnetic prospection *(fig. 6a)* revealed a series of pit-like anomalies and two indications of burial mounds, or circular ditches that may have surrounded an eroded burial mound *(fig. 16,2–3)*. The 80–100 pit-like anomalies have a maximum of 5 nT and have a diameter of 1.5–2.0 m *(fig. 16,1)*. The small number of pits and the modest amount of settlement activity suggest that the site was only used for a short period of time.

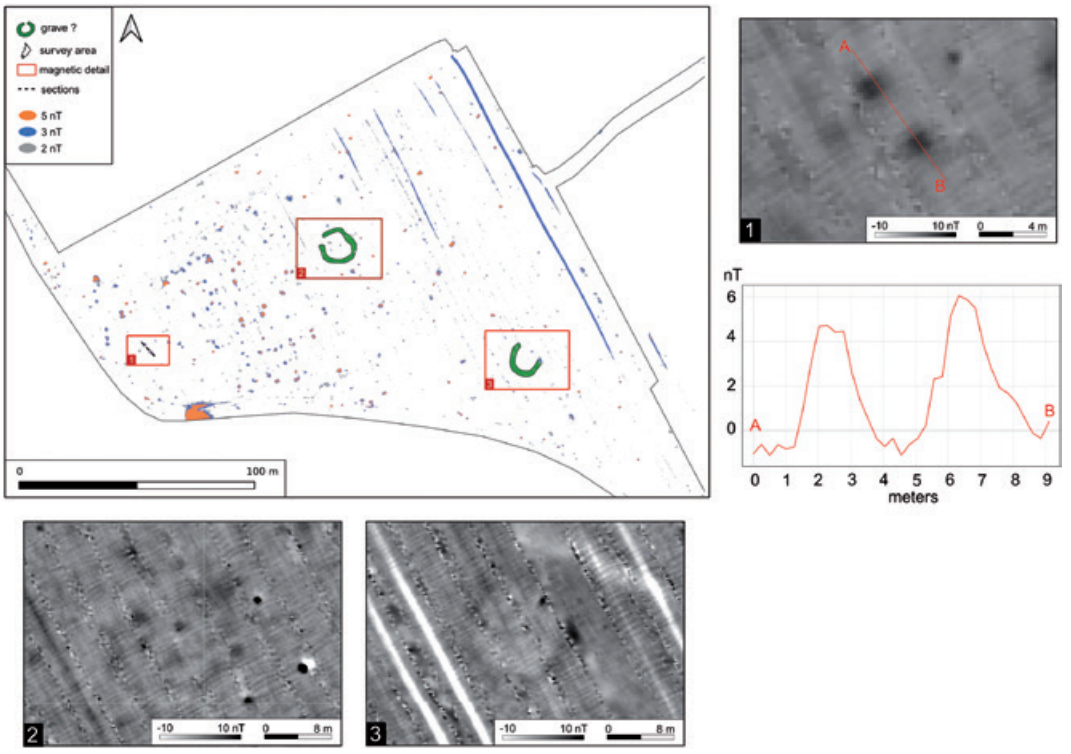


Fig. 16. Horodişte-Ţipova Buciuşca IV. Contour map of anomalies with the location of the magnetic map and section through two pits (1) and magnetic maps of two circular structures, probably graves (2–3) (images: M. Kohle).

Unfortunately, at the site Buciuşca V no features were detected, so we have to discuss the origin of the surface findings that led to the conclusion that there had to be a settlement.

Magnetometer Surveys at Iron Age Sites in the Middle Dniester Area

In the Republic of Moldova, magnetic prospections were carried out at the Iron Age sites of Saharna Mare (Niculiţă et al. 2012; Asăndulesei 2016) and Saharna Rude (Zanoci et al. 2020a). The settlement of Saharna Mare was prospected in 2010 and 2015 by the Arheoinvest Platform from the "Alexandru Ioan Cuza" University of Iaşi, Romania. The surveyed area covered about 6 ha, including the enclosed settlement and extending to the defensive structures in the western part of the site. The magnetometer results revealed numerous geophysical anomalies characterized by high values of magnetic susceptibility, many of them with values of up to 20 nT (Asăndulesei 2016, 38). Some of these anomalies were confirmed by excavation, allowing the identification as the remains of defensive and habitation structures *(fig. 17)*.

The magnetic prospection at Saharna "Rude" was carried out over an area of about 3 ha. Here several anomalies were identified, including one located on the northern edge of the settlement. It is circular in shape and consists of two concentric lines, the first with a diameter of about 50 m and the second of 75 m. To verify the circular anomaly, archaeological excavations were carried out on its northern side. It was discovered that the anomaly was

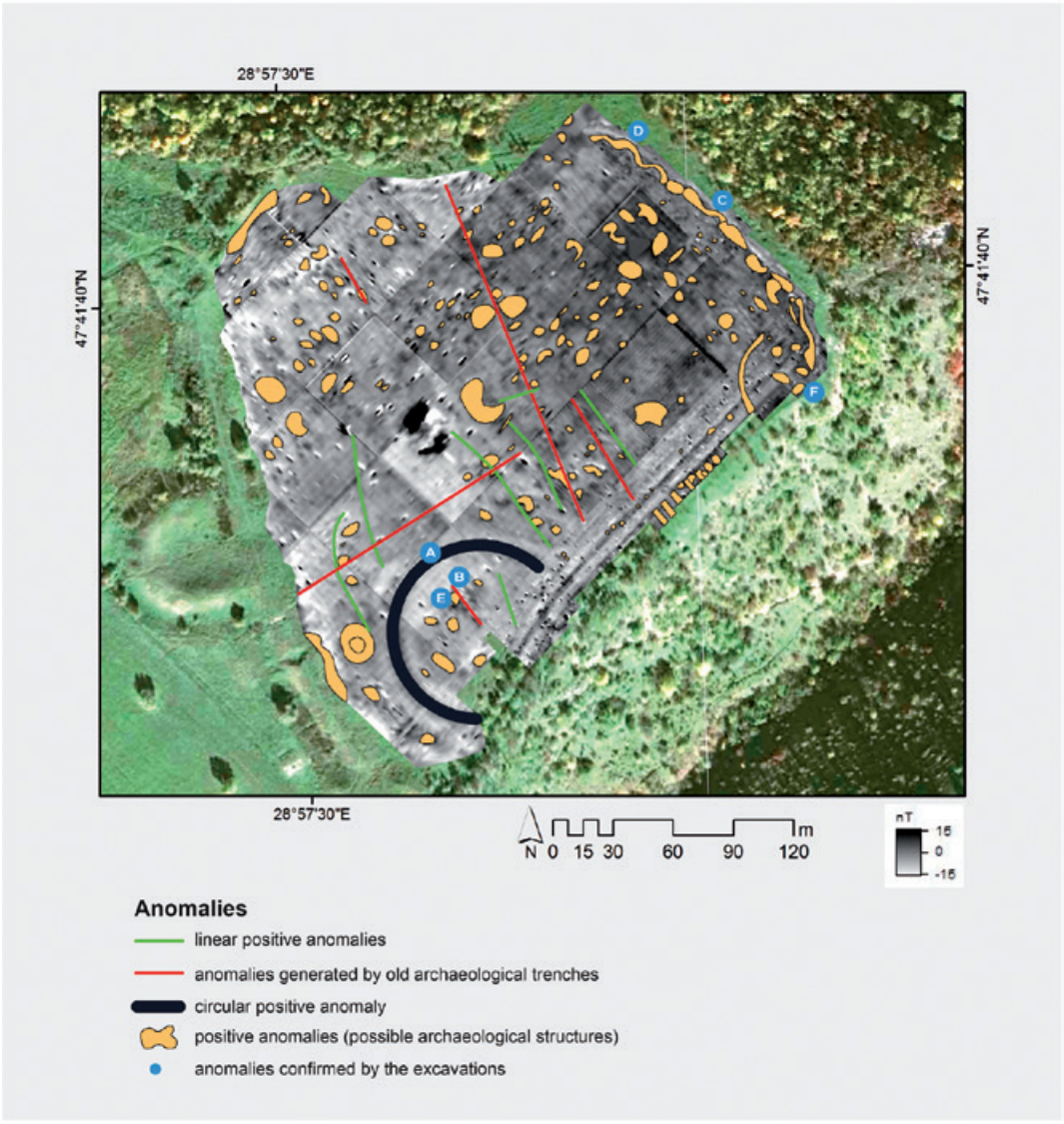


Fig. 17a. Saharna Mare – Magnetic prospections and interpretations (map: after Asăndulesei 2016, fig. 22.2 with additions by M. Băţ).

generated by a defensive ditch with width of 1.1 m and a depth of about 1.80 m (Zanoci et al. 2020a, 53 fig. 2,1). Several positive, pit-like anomalies were also attested throughout the site (Zanoci et al. 2020a, 53 fig. 1).

Aerial Photography and UAV-Imaging

From the start of the new investigations in Horodişte, orthophotos of the main settlement with its sections "La Cot" and "La Şanţ" were analysed. They showed the ramparts between the spur "La Şanţ" and the outer area "La Cot". Furthermore, the ramparts and ditches surrounding nearly the whole plateau and several interruptions in them are visible,

Fig. 17b. Saharna Mare – sample excavations (photos: A. Zanoci, M. Băţ and S. Matveev).

and there are also some possible structures along the northwestern slope of the plateau *(fig. 18a.b)*. In a more detailed view *(fig. 19)* it is clear that the course of the rampart is undulated, so that it appears as if there are some bastions along the rampart. This special feature has already been discussed (by e. g. Zanoci / Niculiţă / Băţ 2019, 320 f.) and is dated to the 4th–3rd century BC (Niculiţă / Zanoci / Băţ 2014).

During the fieldwork, several flights with a UAV-System consisting of a DJI Phantom I and an assembled GoPro Hero3-camera were undertaken to obtain orthophotos and an SfM-model of the "La Şanţ" area. Unfortunately, the weather conditions were unfavourable. Fog, drizzle, winds and also biological hinderances posed considerable dangers. All in all, three flights were absolved. The images were processed at the Institute for Pre- and

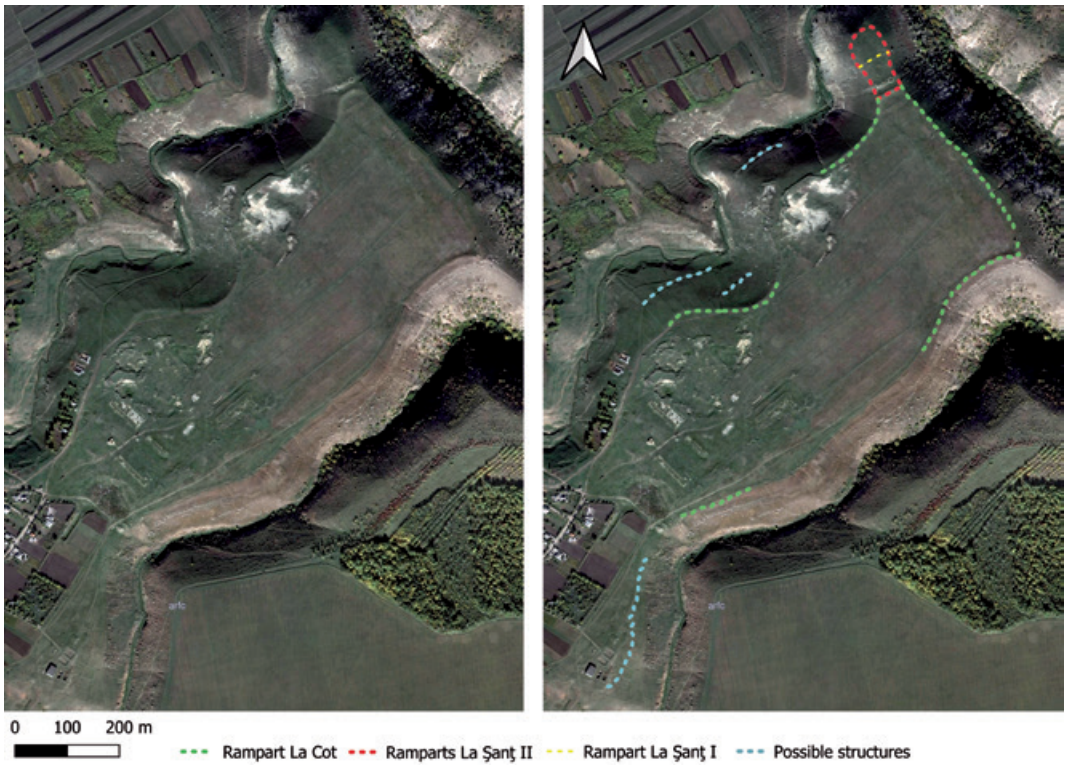


Fig. 18. Features detected based on the analysis of orthophotos (photos and editing: D. Scherf, A. Zanoci and M. Băţ).

Proto-History of Philipps-University Marburg, and despite all the adversities they provided a usable terrain model that visualizes the preserved structures *(fig. 7)*. The same procedure will be applied to several features at "La Cot", e. g. the bastions near the ramparts of "La Şanţ", where the preservation of the features is best. In our DEM, four ramparts and a probably recent field boundary are visualized. We assume that at least two of these defensive features (ramparts 1 and 2) were built at the same time. Their construction, dimensions and location indicate that they are part of a gate to the spur, which is a common feature of fortifications in the region (Zanoci / Băţ 2020, 111–122 and figs 1–7). Unfortunately, the surrounding rampart seems to be in a worse condition than the rampart crossing the spur. Especially in the south-western area of "La Şanţ" it is not clear if the rampart is connected to one of the impressive main ramparts, but it can be assumed that in this zone it also ran along the edge of the plateau. From the preserved state of ramparts 1–3 we are able to calculate the theoretical volume of earth moved, although some critical consideration is necessary.

Based on the DEM, and of course idealized, we consider length (l), height (h), width at the base (w1) and the width at the top (w2). It is also assumed that the shape of the rampart formed an ideal and straightened geometrical body of trapezoid shape. Hence the formula to calculate the possible volume in *Table 2* shows values and the results. If we take these values as a basis and assume a weight of 1.3 t per m^3 of earth for rampart 1, 1,375.4 t of earth were moved to build the rampart. Similarly, we have to presume 600.6 t for rampart 2 and 47.1 t of earth for rampart 3. Apart from earth, a lot of stone was usually used to

Fig. 19. Detail of the undulating rampart (D. Scherf, A. Zanoci and M. Băţ).

Rampart	Dating	w1 in m	w2 in m	h in m	l in m	V in m²	Earth in t
1	Late Iron Age	15	5	2,3	46	1058	1375,4
2	Late Iron Age	10	4	1,5	44	462	600,6
3	Early Iron Age	3	1,3	0,3	56	36,23	47,1

Tab. 2. Calculated volumes of the ramparts (D. Scherf).

build ramparts during the Iron Age in the Middle Dniester region (Niculiţă / Zanoci / Arnăut 2008; Niculiţă / Zanoci / Băţ 2016), and it should be mentioned that any stone and wooden substructures included in the rampart are not included in our calculations because the construction of ramparts 1 and 2 has not been investigated yet. Also, this theoretical model ignores the gradients of the front faces. If we assume a daily volume of earth movement of 1.8 m³/person (Lobisser / Neubauer 2006, 87) and ten persons working,

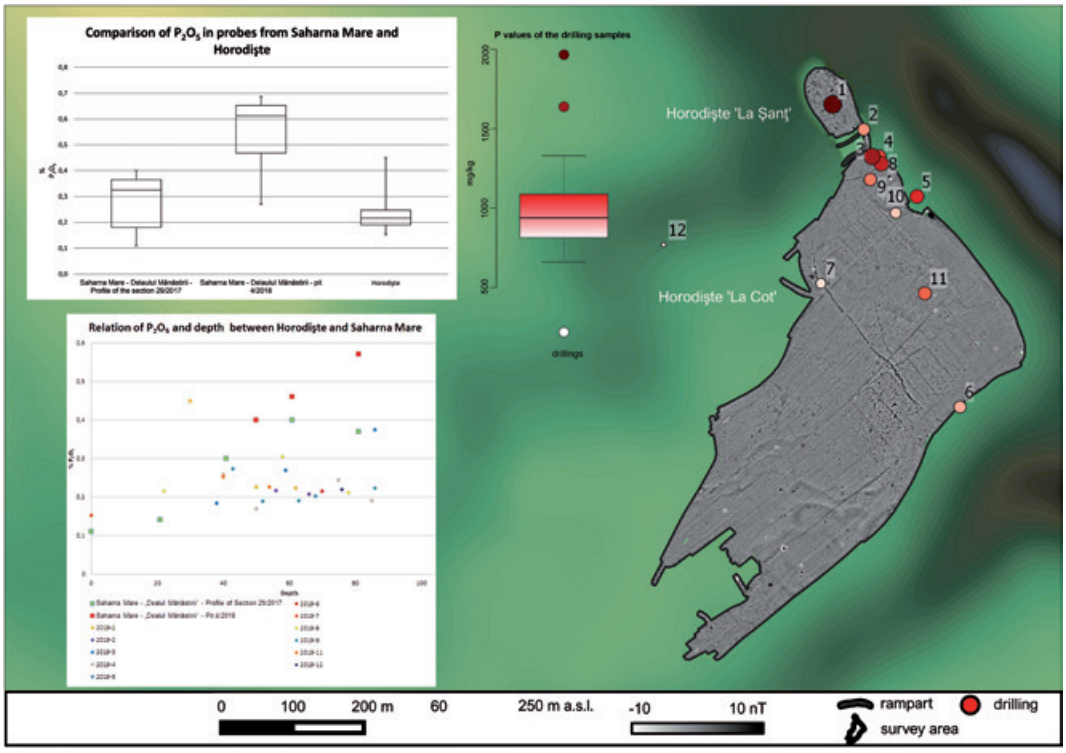


Fig. 20. Magnetic map of Horodişte "La Şanţ", "La Cot" with the location of the drillings from 2019 combined with a boxplot of the Ptot values and the plot of the maximum Ptot values of the drillings coloured from white to dark red. A second boxplot shows a comparison of the P2O5 values from Horodişte-Ţipova and Saharna (M. Kohle, D. Scherf and I. Hohle).

using spades and carrying bags (concurrent skeletal deformations from carrying bags are known from the region, e. g. Băţ / Simalcsik / Zanoci 2019, 25–28, fig. 11,3.4), rampart 1 could have been built in six days, rampart 2 in three days and rampart three in less than one day. However, it should not be forgotten that much more time was needed to process the wood and stone used for the presumed substructions. Furthermore, the earth that is filled in the substruction has to be compressed constantly. Thus, the whole rampart construction must be imagined as a dynamic, complex process with different subprocesses of raw material gathering, managing and construction (Scherf / Mewes 2021). Thus as long as we have no detailed knowledge of how the ramparts were constructed, we are not able to calculate accurately the time it took to erect the features. Of course, these calculations remain theoretical and vague, but they illustrate the required capacities and give an idea of the extent of ancient achievements.

Drillings

In order to make statements about the intensity of use and in some cases also the preservation of the structures obtained in the area, as well as about interesting anomalies from the magnetic prospection, twelve drilling samples were taken with a Pürckhauer (sonde) ground auger from a depth of up to 1 m *(fig. 20; tab. 3)*. Unfortunately, in many of the sections the sediment was too dry to be brought up to the surface. Due to the loss of the

Core	depth	Feature	Probes
		"La Şanţ"	
2019-1	100 cm	Minor rampart across the spur	Probe 2019-1-1 (30–49 cm); Probe 2019-1-2 (49–61 cm); Probe 2019-1-3 (61–96 cm); Probe 2019-1-4 (96–100 cm)
2019-2	100 cm	Inner side of the main ramparts in the passage	Probe 2019-2-1 (56–65 cm); Probe 2019-2-2 (65–100 cm)
		"La Cot"	
2019-3	100 cm	Nearly flattened rampart in front of the main ramparts to La Şanţ	Probe 2019-3-1 (38–58 cm); Probe 2019-3-2 (58–85 cm); Probe 2019-3-3 (85–100 cm)
2019-4	100 cm	Inner side of the undulating fortification	Probe 2019-4-1 (40–49 cm); Probe 2019-4-2 (49–74 cm); Probe 2019-4-3 (74–84 cm); Probe 2019-4-4 (84–100 cm)
2019-5	100 cm	Outer side of the undulating fortification	Probe 2019-5-1 (43–67 cm); Probe 2019-5-2 (67–100 cm)
2019-6	100 cm	Rampart of the undulating fortification	Probe 2019-6-1 (80–100 cm)
2019-7	100 cm	Passage through the south-western fortification discovered by the magnetics	Probe 2019-7-1
2019-8	100 cm	Ditch according to the nearly flattened rampart in front oft he main ramparts to La Şanţ	Probe 2019-8-1 (22–38/42–57 cm); Probe 2019-8-2 (57–77 cm); Probe 2019-8-3 (77–96 cm); Probe 2019-8-4 (96–100 cm)
2019-9	100 cm	Cluster of pits discovered by the magnetics	Probe 2019-9-1 (46–52 cm); Probe 2019-9-2 (52–62 cm); Probe 2019-9-3 (62–85 cm); Probe 2019-9-4 (85–95 cm); Probe 2019-9-5 (95–100 cm)
2019-10	100 cm	Semicircular structure near the main ramparts discovered by the magnetics	Probe 2019-10-1 (rest of humid material); Probe 2019-10-2 (rest of layer above the weathering zone oft he C-horizon); Probe 2019-10-3 (weathering hzone oft he C-horizon)
2019-11	70 cm	Cluster of pits discovered by the magnetics	Probe 2019-11-1 (45–55 cm); Probe 2019-11-2 (55–70 cm)
2019-12	100 cm	Possible rampart parallel to the northwestern slope	Probe 2019-12-1 (62–76 cm); Probe 2019-12-2 (76–100 cm)

Tab. 3. Drilled features of the site and according to the geomagnetic measurements (D. Scherf and M. Mewes).

Nr.	Coordinates	Depth	Colour	Description
			Horodişte "La Şanţ"	
2019-1	647309.282; 5275779.767	0–30 cm		core loss
2019-1-1		30–49 cm	7,5YR3/1	A-horizon; chernozem/humus; Fine sand, homogeneously sorted, with organic components and rooting; not binding, stored loosely; very little inorganic inclusions (lime)
2019-1-2		49–61 cm	5YR5/1	fine sand, homogeneously sorted, decreasing rooting; not binding, stored loosely; appears washed out; very little inorganic inclusions (lime) of different sizes (1–3 mm)
2019-1-3		61–96 cm	2,5YR5/1	silty fine sand, homogeneous sorting, very little rooting; not binding, stored loosely; heterogeneous distribution of inorganic inclusions (rounded limestones, 2–5 mm, increasing towards the bottom)
2019-1-4		96–100 cm	2,5YR6/1	beginning C horizon (?);not cohesive, loosely stored, crumbly, very high proportion of small fractional lime inclusions
2019-2	647352.957; 5275744.622	0–56 cm		core loss
2019-2-2		56–65 cm	5YR4/1	silty fine sand; homogeneous distribution, heterogeneous skeleton; inorganic inclusions up to 5 mm in diameter (lime); little rooting; not binding, stored loosely
2019-2-2		65–100 cm	7,5YR5/1	sandy silt; heterogeneous enforcement with lime inclusions (2–5 mm); not binding, stored loosely; between 96 and 100 cm stronger limescale penetration (beginning C-horizon?)
			Horodişte "La Cot"	
2019-3	647374.548; 5275706.677	0–38 cm		core loss
2019-3-1		38–58 cm	7,5YR3/2	rest of the A-horizon, chernozem/humus; strongly rooted; fine sand with very little silt; heterogeneous distribution of inorganic inclusions (lime, 2–3 mm diameter); not binding, stored loosely
2019-3-2		58–85 cm	5YR5/1	culture layer; fine sand with little silt; charcoal, fired clay, ash flakes of less than 1 mm in size; moderately rooted; heterogeneous distribution of inorganic inclusions (lime, 2–15 mm diameter)
2019-3-3		85–100 cm	7,5YR5/1	culture layer; Fine sand with little silt; Inclusions of bricked material, charcoal, lime crumbs (2–12 mm diameter); no rooting; not binding, stored loosely
2019-4	647425.480; 5275649.363	0–40 cm		core loss
2019-4-1		40–49 cm	5YR5/1	rest of the A-horizon, chernozem/humus; silty fine sand; strongly rooted; heterogeneously distributed small scale inclusions (approx. 2 mm) not cohesive, loosely stored
2019-4-2		49–74 cm	5YR5/1	culture layer; silty fine sand; homogeneously distributed inclusions of ceramics, fired clay, charcoal and burnt and unburned limestone blocks (max. 2 mm diameter); very little rooting; stored loosely, not binding
2019-4-3		74–84 cm	5YR3/1	culture class / running horizon (?); silty fine sand; very clear transition to the overlying layer; few bits of fired clay and lime distributed heterogeneously

Tab. 4. Documentation of the drillings and the probes 2019 (D. Scherf and M. Mewes).

Nr.	Coordinates	Depth	Colour	Description
2019-4-4		84–100 cm	5YR4/1	culture layer; silty fine sand; homogeneously distributed inclusions of ceramics, fired clay, charcoal and burnt and unburned limestone blocks (max. 2 mm diameter); very little rooting; stored loosely, not binding
2019-5	647427.655; 5275650.452	0–43 cm		core loss
2019-5-1		43–67 cm	7,5YR2,5/1	humorous, silty fine sand; homogeneous distribution of lime and ceramics; moderate rooting; not binding, stored loosely
2019-5-2		67–100 cm	5YR3/1	slightly humic, silty fine sand; homogeneously distributed inclusions of lime, non-cohesive, loosely stored
2019-6-1	647487.984; 5275354.836	70–100 cm		After several attempts to remove a core in the immediate vicinity of Sondage 2013, the process was canceled. The sediment was stored too loosely and dried out. A sample was only taken in the area of approx. 80–100 cm depth, no further documentation was provided.
2019-7-1	647292.839; 5275528.339			Due to the very loose and dry storage of the material, almost complete core loss. The bottom of the drilled trench was not reached with a depth of 100 cm. A sample was taken from the possible culture layer. This comes from the remaining material at the borehole.
2019-8	647377.579; 5275696.519	0–22 cm		core loss
2019-8-1		22–38 cm	5YR2,5/1	humus, silty fine sand, little to moderately rooted; few inclusions of lime (2–3 mm diameter), heterogeneously distributed and increasing towards the bottom; stored loosely, not binding
		38–42 cm		core loss
2019-8-1		42–57 cm	5YR2,5/1	like 22–38 cm
2019-8-2		57–77 cm	7,5YR3/1	culture layer; little humus, silty fine sand; Inclusions of lime, fire clay, charcoal (2–6 mm diameter); Calcareous portions homogeneous, remaining inclusions distributed heterogeneously; stored loosely, not binding
2019-8-3		77–96 cm	7,5YR4/1	culture layer; silty fine sand; little inclusions of charcoal and fire clay; Lime content significantly higher than with layered layer; Lime (6–8 mm diameter) homogeneous, rest heterogeneously distributed; not binding, stored loosely
2019-8-4		96–100 cm	7,5YR4/1	silty fine sand; very high lime content, beginning C horizon; stored loosely, not binding
2019-9	647362.150; 5275674.280	0–46 cm		core loss
2019-9-1		46–52 cm	7,5YR4/1	chernozem/humus; humorous, silty fine sand; moderately rooted; heterogeneously distributed inclusions of lime (very little, diameter 3–10 mm); stored loosely, not binding
2019-9-2		52–62 cm	7,5YR5/1	less humous, silty fine sand; little rooted; Inclusions of lime, very little fire clay, burnt lime; heterogeneous distribution of inclusions, only unfired lime (diameter 2–4 mm) homogeneously distributed; loosely stored, not binding; Smooth transition to the underlying layer

Tab. 4. cont.

Nr.	Coordinates	Depth	Colour	Description
2019-9-3		62–85 cm	5YR5/1	culture layer; fine sand with very little silt; inclusions of burnt and unburned lime, fire clay, charcoal and ash; unbaked lime homogeneous, rest heterogeneously distributed (fraction approx. 3–7 mm); especially more ash downwards; loosely stored, not cohesive, smooth transition to underlying layer
2019-9-4		85–95 cm	7,5YR7/1	fine sand; high proportions of ash and lime (grain size 2–3 mm); partially burnt lime in between, charcoal, inclusions distributed homogeneously; loosely stored, not cohesive, smooth transition to underlying layer
2019-9-5		95–100 cm	7,5YR5/1	fine sand; inclusions of lime, quicklime, ash, but less than in the overlying layer; grain size of the unfired lime up to 15 mm; stored loosely, not binding
2019-10	647397.750; 5275627.24			core was not documented in detail due to the excessive loss. Only three samples were taken from the failed material and the residues remaining in the core.
2019-10-1				rest of humid sediment
2019-10-2				rest of beginning C-horizon
2019-10-3				rest of C-horizon with ash
2019-11	647438.640; 5275514.339	0–40 cm		core loss
2019-11-1		45–55 cm	10YR2/1	humorous, silty fine sand (chernozem); deeply rooted, high proportion of organic inclusions as well as lime and burnt clay; strongly cohesive, loosely stored; higher soil moisture than in other areas
2019-11-2		55–70 cm	7,5YR5/1 bzw. 4/1	culture layer; fine sand with very low silt content; ash, charcoal flakes; stored loosely, not cohesive, drier than the overlying layer
2019-12	647072.049; 5275582.683	0–62 cm		core loss
2019-12-1		62–76 cm	7,5YR3/3	very damp, silty sand; inclusions of lime, charcoal and organic matter distributed homogeneously; loosely stored, medium binding, medium formable
2019-12-2		76–100 cm	7,5YR4/3	sandy clay; inclusions of lime distributed homogeneously; very cohesive, loosely stored, easy to shape

Tab. 4. cont.

first 30–40 cm of drilling cores, the upper sediments cannot be taken into account for stratigraphic interpretations and chemical analyses. The samples were labeled according to separate layers, and one sample taken from each layer recognized was sent to Moldova State University (Chişinău) for laboratory examination. During the fieldwork the layers were documented by way of photographs and written descriptions. These included the type of soil, color (according to Munsell Color Charts) and the inclusions of charcoal, ceramics, fired clay, plant remains and stones. *Table 4* gives an overview of the cores and samples taken. The drillings carried out in 2019 are understood as initial test on interesting structures mapped in the magnetic survey, and the values gained have to be confirmed by systematic drillings across the entire plateau, as well as excavation of the drilled features in the future. Especially the excavation of features visible in the survey will make it possible for us to get samples from significant cultural layers and archaeological structures. This

may be a way to clarify if recent soil formation, bioturbation or agricultural use have falsified the values and so help avoid false conclusions.

Soil chemical analysis

As a result of laboratory investigations, it has been established that the soil subtype in the area of the Horodişte archaeological site is Chernozem carbonate, probably in its virgin state. *Table 5* shows the results of the chemical analysis. The middle Sarmatian limestone served as the parent rock for the Chernozem carbonate, and the soil was formed under the natural conditions of xerophytic steppe, with Deschampsia, Stipa capillata, and Artemisia. This soil subtype is medium humic, relatively stable in structure and contains surface carbonates. In the Horodişte-Ţipova micro-region the Chernozem carbonate is usually present on the plateaus and promontories formed at the confluence of the Dniester with its right-bank tributaries, or those formed only by tributaries of the Dniester. The presence of carbonates in the upper layer indicates a xerophytic water regime. Carbonates interact with nutrients, passing them in an insoluble state, and the soil reaction is basic (Ursu 2006; Ursu 2011).

The role of phosphorus as one indicator of anthropogenic impact has long been accepted and discussed in archaeology (Provan 1971; Salisbury 2012; Holliday / Gartner 2007 [for further literature see tab. 1; 2, p. 302]; Salisbury 2020). Anthropogenic phosphorus can originate from human impact such as waste, barns, burials, excrement, fertilizers etc. In its common form, phosphate, it is quite stable in the soil and thus of interest for archaeological research.

According to the statistical data resulting from the analysis of soil samples by the molecular absorption spectrophotometric method[5], in the Chernozem carbonate of the region the total phosphorus content (Ptot) in the top 50 cm is 830–1090 mg/kg, or 960 mg/kg on average, and at a depth of 50–100 cm 650–1050 mg/kg, or 850 mg/kg on average (Почвы Молдавии 1984, 66). In the soil samples taken from the Horodişte archaeological site, the Ptot content is higher in almost all cases, in particular in those from Horodişte "La Şanţ", at all depths (samples 1-1; 1-2; 1-3 and 2-1; 2-2). The maximum value is from sample 1-1 at a depth of 30–49 cm (1965.24 mg/kg), which was taken from the ditch that is clearly visible in the magnetic survey. This could be interpreted as anthropogenic backfilling of the ditch, whereas samples 2-1 and 2-2, taken from the rampart, would suggest that the rampart was built at an earlier phase of the settlement.

In the soil samples from Horodişte "La Cot" the content of Ptot is more variable, having higher values, which exceed the standard average in samples 3-2 and 3-3, from a depth of 58–100 cm, and in samples 5-1 and 5-2. The maximum value is reached in sample 3-3 from a depth of 85–100 cm (1637.46 mg/kg) *(tab. 5)*. The higher values in sample 8 are to be seen in the context of sample 1 (ditch of La Şanţ), as it is taken from the ditch that separates the area from "La Şanţ". The higher Ptot (1329.64 mg/kg) fits the description of a culture layer with charcoal and fired clay. Sample 3 is situated in the enclosed area towards "La Şanţ".

Considering that the Ptot content in chernozems is expected to decline with soil depth (Spychalski et al. 2018, 41), it would appear that samples 3, 4, 8, 9 and 10 imply anthropogenic influence on the soil. It should be noted that the sediment samples were not taken

[5] Molecular absorption spectrophotometric method was applied according to SM SR ISO 11263:2012, SM SR ISO 14869-1:2012, SM ISO 6491:2014, GOST 26261-84, GOST 26205-91.

Nr.	Coordinates of the probe	Probe number	Depth (cm)	Nitrogen total			Phosphorus total		
				% Ntotal	standard media (mgN/kg)	result in the probe (mg/kg)	% P2O5	standard media (mgP/kg)	result in the probe (mgP/kg)
Horodişte "La Şanţ"									
1	647309.282; 5275779.767	1-1	30–49	0.4928	1900	4928	0.450	906	1965.24
		1-2	49–61	0.5264	1900	5264	0.226	906	984.76
		1-3	61–96	0.3024	1330	3024	0.223	850	973.36
2	647352.957; 5275744.622	2-1	56–65	0.4368	1330	4368	0.217	850	946.28
		2-2	65–100	0.154	1330	1540	0.208	850	909.23
Horodişte "La Cot"									
3	647374.548; 5275706.677	3-1	38–58	0.3724	1900	3724	0.184	906	800.92
		3-2	58–85	0.3108	1330	3108	0.269	850	1174.30
		3-3	85–100	0.1652	1330	1652	0.375	850	1637.46
4	647425.480; 5275649.363	4-1	40–49	0.4284	1900	4284	0.259	850	1131.54
		4-2	49–74	0.2772	1330	2772	0.170	850	743.91
		4-3	74–84	0.2772	1330	2772	0.245	850	1070.26
		4-4	84–100	0.2884	1330	2884	0.190	850	827.99
5	647427.655; 5275650.452	5-1	43–67	0.4004	1900	4004	0.274	906	1194.25
		5-2	67–100	0.2884	1330	2884	0.203	850	887.85
6	647487.984; 5275354.836	6-1	70–100	0.28	1330	2800	0.216	850	940.58
7	647292.839; 5275528.339	7-1	-----	0.4004	1900-1330	4004	0.152	906-850	661.26
8	647377.579; 5275696.519	8-1	22–38 and 42–57	0.4508	1900	4508	0.215	906	936.30
		8-2	57–77	0.3444	1330	3444	0.305	850	1329.64
		8-3	77–96	0.2464	1330	2464	0.212	850	926.33
9	647362.150; 5275674.280	9-2	52–62	0.28	1330	2800	0.189	850	826.57
		9-3	62–85	0.1708	1330	1708	0.190	850	830.84
		9-4	85–95	0.098	1330	980	0.224	850	976.21
10	647397.750; 5275627.24	10-1	-----	0.3444	1900-1330	3444	0.172	906-850	752.46
		10-2	-----	0.2436		2436	0.168		733.94
		10-3	-----	0.056		560	0.176		766.71
11	647438.640; 5275514.339	11-1	40–55	0.308	1330	3080	0.253	906	1104.47
		11/-2	55–70	0.126	1330	1260	0.226	850	984.76
12	647072.049; 5275582.683	12-2	76–100	0.1232	1330	1232	0.22	850	219.47

Tab. 5. Results of the soil chemical analysis (T. Nagacevschi, V. Sochircă and M. Podgorelec).

at the same depths, but for each layer, and are therefore difficult to compare with each other, and other settlements and fortifications.

Samples with a higher total phosphorus content (Ptot) in the soil may be indicators of the accumulation of phosphorus compounds resulting from transforming products of human activity in the past, such as: food waste, ash, faeces, and other household waste. Holliday and Gartner claim that, beside phosphorus, "the most common chemical elements affected by human activity are carbon, nitrogen, sodium calcium, with lesser amounts of potassium, magnesium, sulphur, copper, zinc and other metals." (Holliday / Gartner 2007, 302, quoted after Cook / Heizer 1965, 1–3; Eidt 1984, 25–27; Woods 1982, 1396–1399). A major difficulty of determining phosphorus in the soil is that it has not yet been determined which soil phases are responsible for phosphorus retention in different archaeological soils and features (Oonk et al. 2009, 36). Therefore, phosphorus could be a problematic indicator of human occupation, as noted by Oonk, Slomp and Huisman (Oonk et al. 2009, 36, quoted after Entwistle et al. 1998, 53–68; Entwistle et al. 2000a, 287–303; Entwistle et al. 2000b, 171–188).

Given that the measurements are based on Ptot, the results of such analyses should be treated with considerable caution, since Ptot includes all mineral phosphorus, which can be significantly higher than anthropogenic phosphorus (Holliday / Gartner 2007, 314). Taking advantage of a geochemical baseline comprising the natural soil and other element enrichments in the soil, such as calcium, magnesium or strontium, and combining it with magnetic prospection results could significantly assist the interpretation of phosphorus data, distinguishing natural from anthropogenic influences (Oonk et al. 2009, 36).

Beside phosphorus, nitrogen is also recognized as being one of the indicators of anthropogenic impact, altering the natural nitrogen cycle in many terrestrial ecosystems in terms of human land use and cultivation practices for food and fodder production (Fraser et al. 2011). The use of animal manure to improve overall soil fertility is one of the most influential effects on soil nitrogen dynamics (Frazer et al. 2011, 2790, quoted after Bol et al. 2008; Choi et al. 2006; Senbayram et al. 2008). However, there is still considerable uncertainty with regard to nitrogen, due a lack of available literature on nitrogen analysis for archaeology.

The total nitrogen analysis was chosen in order to determine whether the nitrogen in the Horodişte soil samples is anthropogenic or natural. Once the total nitrogen analysis had been done, the Ntot content from the archaeological site was compared to the Ntot content in non-anthropogenic natural profiles (control profile). It is important to note that Ntot in natural profiles is not contained in the humid upper horizons of the soil, nor in the underlying soils at depths greater than 50–60 cm (sometimes up to 1–2 m). Therefore, the presence of Ntot at great depths is indirect proof of anthropogenic impact. The soil samples were compared to the standard values for the Ntot content in different soil types at different depths, contained in the normative acts of the Republic of Moldova (Hotărâre 2012).

As a result, the parameters of total nitrogen content (Ntot) in Chernozem carbonates can also be characterized. The average content in depths of 0–50 cm is 1700–2200 mg/kg, or an average of 1950 mg/kg, and 900–1700 mg/kg or an average of 1330 mg/kg at depths of 50–100 cm (Почвы Молдавии 1984, 67). The Ntot content of the soil samples investigated was determined by the volumetric method[6] and is clearly elevated in practically all

[6] The volumetric method was applied according to SM SR ISO 11261:2012, SM SR EN ISO 5983-2:2009.

the samples, above all in those from Horodişte "La Şanţ" (samples 1-1; 1-2; 1-3 and 2-1; 2-2), with maximum values in samples 1-1 and 1-2 from a depth of 30–61 cm (4,928 and 5,264 mg/kg respectively), reflecting a 2.6–2.8-fold increase compared to the standard average content. Regarding soil samples from Horodişte "La Cot", the content of Ntot varies, showing higher values that significantly exceed the standard average: in sample 4-1 (4284 mg/kg) from a depth of 40–49 cm and in sample 8-1 (4508 mg/kg) at 22–57 cm *(tab. 5)*. Elevated total nitrogen contents (Ntot) in soil at depths greater than 50 cm are not typical for Chernozem carbonate soils with an intact genetic profile, as nitrogen (N) is a product of the presence and activity of biological factors (vegetation) or human agricultural activity (cultivation of plants, its products and residues; manure and animal urine), and is present in the surface layer accumulating humus.

Thus, as a result of the pedological analysis it was found that the total phosphorus (Ptot) and the total nitrogen contents (Ntot) in soil samples from the Horodişte archaeological site significantly exceed the standard average. The higher total content of nitrogen (Ntot) and phosphorus (Ptot) in the samples from Horodişte "La Şanţ" is the result of longer and more intense habitation (10th–9th centuries BC and 4th–3rd centuries BC) compared to the "La Cot" settlement which, according to preliminary data, existed only in the 4th–3rd centuries BC.

The manifestations of the total phosphorus content (Ptot) and nitrogen contents (Ntot) in soil can be compared to those attested at the archaeological site of Saharna Mare / "Dealul Mănăstirii" located about 8.5 km north of Horodişte (Nagacevschi et al. 2019, 323–345) *(fig. 20)*. Unfortunately, the context of the samples taken from trench 29/2017 and pit 4/2018 at Saharna Mare is different. The values published by Nagacevschi et al. (2019, tab. 1) clearly show an increase of the P2O5 values correlated to the depth in definite archaeological structures. However, the higher values of P2O5 in the samples from Horodişte come from more superficial layers *(tab. 5)*. This could be related to livestock farming in the Soviet era; the ruins of a local cooperative are still visible in the southwest of the plateau. Further research is needed to clarify this hypothesis.

Conclusions and future research

The aim of our research is to take a closer look at social, economic and environmental dynamics in the Horodişte-Ţipova micro-region in order to gain data that facilitates generalized statements on the cultural-historical development of the Eastern Carpathian area. This paper is to be understood as a first step towards understanding one of several settlement clusters in the Middle-Dniester area chosen as a sample region. This understanding will provide an opportunity to define the factors and processes that led to the increase in the number of fortifications and of the population. A further focus of research is environmental development, both human and natural.

The campaign of 2019 provided further information about the large spur and its settlement. A rampart and an accompanying ditch were discovered, which seal off fortification to the southwest. The magnetic prospection also revealed different intensity of use in parts of the hillfort of Horodişte "La Cot". While some areas seem to be nearly free from archaeological features, others contain numerous different structures interpreted as house remains, post holes and pits. Until now the dating of these features remains unclear. In comparison to Horodişte "La Şanţ", it is evident that this area was more intensively settled. As we know that the entire agglomeration was used in two periods, we have to assume that "La Şanţ" was used in both while "La Cot" seems to have been inhabited in only one. Of course, the architecture of the features detected in "La Şanţ" could also have been more

substantial than those on the outer spur, but only excavations can provide indications for the internal chronology of the site.

For the archaeological sites Buciuşca IV and V, only in Buciuşca IV were significant archaeological features detectable.

The UAV-imaging delivered accurate data for the survey of Horodişte "La Şanţ". Combined with further flights above Horodişte "La Cot", we aim to generate a complete DEM of the whole settlement agglomeration. From this we shall be able to record and describe the natural environment that the agglomeration was implemented in.

In our future project we will use different methods to obtain a closer view of the cultural and natural space, as well as their development in the first millennium BC.

Palynological analyses are planned to establish the history of vegetation in the region and approach a reconstruction of climatic changes through the ages. The various springs and the Dniester flood plains hopefully have preserved archives that fit in our time frame. Combined with macro remain and phytolith analysis, the picture of the landscape before, during and after the inhabitation phases should become clearer and reveal the human impact in detail. Furthermore, a DEM of the region must be realized and analysed in order to describe the physical environment people lived in and evaluate the features they used, especially the local road network.

As a third and last phase, site-focused research will be scaled up to the wider archaeological environment, and the programme of drillings, botanical and soil analysis should be applied to similar settlement complexes, e. g. in the Dniester-Ciorna region. If we can understand the settlement cluster at Horodişte-Ţipova in its natural and archaeological environment, then such similar sites could be understood and fitted into a macroscopic perspective of social dynamics, as well as interaction, mobility and exchange in the Eastern Carpathian area and beyond.

The data gained should provide information and interpretations that let us understand subsistence, and maybe also resilience in Iron Age communities, not only in the Eastern Carpathian area but also in similar regions. Using the latest natural scientific and landscape archaeological approaches, socio-ecological and socio-economic, as well as power political questions can be addressed. The respective interactions and their significance for the development of settlement structures and social dynamics, but also reactions to challenges and crises, will be examined.

Prospections in Horodişte provided enough data to assess the entire settlement complex. The area of "La Şanţ" was settled in 10th–9th century BC and resettled in the 4th–3rd century BC, which corresponds to the assumed beginning of the settlement at "La Cot". The magnetic survey showed that not the whole area of "La Cot" was settled, but that there are different, separate areas of activity, and a ditch and rampart closed the hillfort to the south-west. The discovery of the previously unknown ditch is a major result of our survey. We are now able to understand the hillfort in relation to its environmental embedding. For example, the sites of the Saharna agglomeration seem to be founded for the same reason: to protect a river crossing. Further investigations are needed to provide information about the development of the micro-region Horodişte-Ţipova and its archaeological environment. Small-scale excavations will be necessary to learn more about the chronological relationships between the settlement areas, and the development of architecture and subsistence strategies. Based on the results of these excavations, a re-evaluation of the 2019 magnetic results will also be needed. Furthermore, Smirnov's trench will be reopened and documented. Sondages will also be undertaken in Buciuşca IV to obtain information on similar questions, in particular the dating of the site. A chronological comparison of the settlement areas detected may also illuminate fluctuations in activity and the rise and decline of the

site agglomerations in a regional and supraregional context. To obtain a better picture of spatial use patterns in the hillfort and to reconstruct the ancient surface, additional drillings will have to be carried out. The samples will be taken across large transects over the hillfort and provide additional material for phosphorus and other chemical element analysis for a better understanding of archaeological features detected in the magnetic anomalies.

In addition, soil samples from stratigraphically secured contexts, i. e. from the profiles documented during the sondages, will confirm or refute the results obtained in 2019, especially with regard to the P and N values and their assignment to cultural layers, taphonomic processes or recent agriculture. Furthermore, any drillings will have to be realized in climatically favourable times of the year, when the soil is more moistened. These data, combined with a stratigraphic modelling of the whole site from large scale drilling transects across the plateau, and correlated to chronological data will help us to see if the areas of activity were in use simultaneously or consecutively, and why maybe some areas were used more intensely than others.

The intended results will be used for modelling and reconstructing population size and settlement intensity (see for example Nowaczinski et al. 2013; Martini et al. 2019) for comparison with other Iron Age fortified settlements, and to set Horodişte-Ţipova in the context of its socio-historical environment. Differentiated statements about the meaning, status and use of the Horodişte-Ţipova micro-region, etc. will then be possible.

By using LIDAR, it should be possible to see if there are more structures in the surrounding area that were related to the main settlement. A detailed surface model of the Horodişte-Ţipova micro-region and the opposite bank of the Dniester will hopefully provide further information, especially when combined with the data already gained. To understand the development of land usage in a larger scale, it is necessary to carry out further drillings in riverbanks and wells in the nearer and the wider surrounding area. Palynological analysis may show if the settlement processes made a recognizable impact in the postulated periods of use. This could also lead to the location of the remains of an assumed river crossing in the valley.

Another main question is the role of the Horodişte-Ţipova micro-region in the system of similar simultaneous settlement complexes in the middle Dniester basin. The data and results obtained must then be compared with similar settlement complexes in both the Dniester region and the Eastern Carpathian area in order to reconstruct how settlement, traffic, trade and exchange functioned there.

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The Iron Age Settlements in the Micro-Region of Horodişte-Ţipova, Distr. Rezina, Republic of Moldova. Magnetic Prospection, UAV Images and Drillings

Summary · Zusammenfassung · Résumé

SUMMARY · This paper presents a preliminary report on a field survey at Horodişte-Ţipova carried out in 2019. During three days of field work, nearly 30 ha of the site agglomeration were prospected with a 14-channel magnetic system. At the same time, three drone flights and twelve drillings were carried out. Based on the results presented here and the upcoming investigations and excavations, we plan to implement a research project that places our results in a wider area in the Eastern Carpathian region. The results of the magnetic survey indicate a large, fortified and structured settlement, and a smaller, open village. Analysis of aerial images suggests that we should expect a complex structured site agglomeration with different dependencies. The soil samples show that the measured values of phosphate and the usage of the spur in recent times need to be taken into consideration. This paper presents the base for our future investigations and presents the concept of our research. We focus on questions of the spatial, social and economic organization of the Iron Age communities in the Horodişte-Ţipova area, as well as in the transition zone between forest steppe and steppe, respectively in the fluvial systems of Dniester and Prut.

ZUSAMMENFASSUNG · Der Beitrag gibt einen Überblick über umfangreiche Voruntersuchungen, die im Jahr 2019 in Horodişte-Ţipova, Republik Moldau, durchgeführt wurden. Die Analyse von Luftbildern sowie Feldbegehungen legten nahe, dass in Horodişte-Ţipova eine komplex strukturierte Siedlungsagglomeration mit einer Großsiedlung und mehreren offenen Siedlungen vorliegt. Während der Kampagne wurden fast 30 ha der Siedlungsagglomeration mit einem 14-Kanal-Magnetometersystem prospektiert. Parallel fanden Drohnenflüge zur Erstellung von sfm-Modellen sowie Bohrungen zur Gewinnung von Proben für erste Phosphat-Analysen statt. Die Ergebnisse der magnetischen Prospektion deuten auf eine befestigte und strukturierte Großsiedlung sowie auf eine kleinere, offene Siedlung hin. Die vorliegenden Untersuchungsergebnisse bilden die Grundlage für zukünftige Forschungen in Horodişte-Ţipova. Hierbei konzentrieren sich die Fragestellungen derzeit auf die räumliche, soziale und wirtschaftliche Organisation der eisenzeitlichen Gemeinschaften in der untersuchten Siedlungsagglomeration sowie in der Übergangszone zwischen Waldsteppe und Steppe bzw. in den Flusssystemen von Dniester und Prut.

RÉSUMÉ · Cet article présente le rapport préliminaire d'une prospection menée en 2019 à Horodişte-Ţipova. Trois jours sur le terrain ont permis de prospecter près de 30 ha du site à l'aide d'un système de mesure magnétique à 14 canaux, de réaliser douze forages et trois vols avec un drone. Sur base des résultats présentés ici, ainsi que des investigations et fouilles à venir, nous comptons réaliser un projet de recherche qui situe nos résultats dans un contexte plus vaste des Carpates orientales. Les résultats de la prospection magnétique indiquent une grande agglomération, organisée et fortifiée, et un petit village ouvert. L'analyse des photos aériennes suggère que nous faisons face à une agglomération structurée de manière complexe dont dépendent différents habitats secondaires. Les échantillons de sol montrent qu'il faut prendre en considération les valeurs mesurées de phosphate et l'utilisation récente de l'éperon. Cet article présente le point de départ de nos prochaines investigations et le concept de notre recherche. Nous visons ici les questions touchant à l'organisation spatiale, sociale et économique des communautés de l'âge du Fer dans la région de Horodişte-Ţipova et dans la zone transitoire entre steppes boisées et steppes, respectivement le long des systèmes fluviaux du Dniestr et du Put. (Y. G.)

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