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Verification of Geophysical Surveys by New Archaeological Excavations on the Grounds of the Middle La Tène Site of Némčice in 2021–2022

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ABSTRACT

The Némčice site located in a strategic area of an agricultural plateau represents one of the most important archaeological sites in Moravia. Non-destructive archaeological surveys including a large-scale magnetometer survey, field artefact collections, and metal detector surveys have been carried out there repeatedly over the past two decades. New archaeological excavations during a new project were focused on selected areas and situations identified during magnetometer prospection. The results of an archaeological investigation of the site using test pits confirmed settlement, glass-making and ritual activity under magnetic anomalies at the site. The new possibility of comparing uncovered sunken features and distributions of magnetic anomalies provided new feedback for a more precise interpretation of similar anomalies from magnetograms. An additional detailed apparent magnetic susceptibility measurement *in situ* showed another possibility for the application of the geophysical method during archaeological excavations. We were able to obtain additional information about the fills or possible post-depositional processes of various sunken features in the case of vertical profiles monitored by magnetic susceptibility meter measurements. The use and combination of various geophysical data has been beneficial in the case of an archaeological site as important as Némčice, and will continue to be so in future archaeological research of the site.

1. Introduction

The vast unfortified settlement, production and trade area from the Middle La Tène period (LTB2–LTC2 – see Čižmář and Danielisová, 2021, p. 206) is a distinctly supraregional centre situated on agricultural land between the towns of Némčice nad Hanou, Víceměřice and Poličky in the Prostějov district.¹ Previous archaeological surveys of the site, including intensive surface collections and detector surveys, have drawn attention to the extraordinary importance of the site, which is closely linked to the course of the Amber Road (Čižmář and Kolníková, 2006; Kolníková, 2006; 2012;

Čižmář *et al.*, 2008; 2018; 2020; Čižmář and Kruta, 2011; Čižmářová *et al.*, 2014; Militký, 2012). Thousands of gold and silver coins, bronze and glass artifacts have been discovered so far during surface surveys and later excavations. Semi-finished products, raw materials and waste from production provide evidence of coinage, bronze metallurgy, iron and amber processing. Numerous findings related to glass processing make Némčice the oldest glass workshop north of the Alps (Čižmář *et al.*, 2023, 215–216). The extraordinarily large area of the site was also confirmed by a systematic non-destructive geophysical survey (Křivánek and Čižmář, 2007; Křivánek, 2014). The results of the magnetometer survey confirmed the large number of archaeological situations preserved just below the topsoil, as well as their non-random distribution on the extensive terrain of the plateau (Křivánek, 2014, Figures 6 and 7; 2019). In several parts of the site, the results of the geophysical measurement were also compared

¹ The site is located in multiple cadastral territories and will therefore be referred to in the following text under the name “Némčice”.

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with the results of other prospecting methods, where different specialised activities were assumed when this information was combined (Křivánek, 2016a; Venclová, 2016).

2. Excavation circumstances

Despite the non-destructive acquisition of this knowledge about the site and its subsequent (at least) general definition as an important immovable archaeological monument,

the site was without any archaeological excavation and verification for many years. The lone attempt to verify the archaeological situation was made in 2004 with a 1×5 m test pit in the northeastern part of the site, during which the situations detected by magnetometer measurements were not reached because the area was incorrectly marked out. The new archaeological project entitled “Central Agglomeration of Némčice nad Hanou. Interdisciplinary Research of a Key La Tène Period Site in Moravia” (Czech Science Foundation, no. 21–24234S, 2022–2024, Čižmář *et al.*)

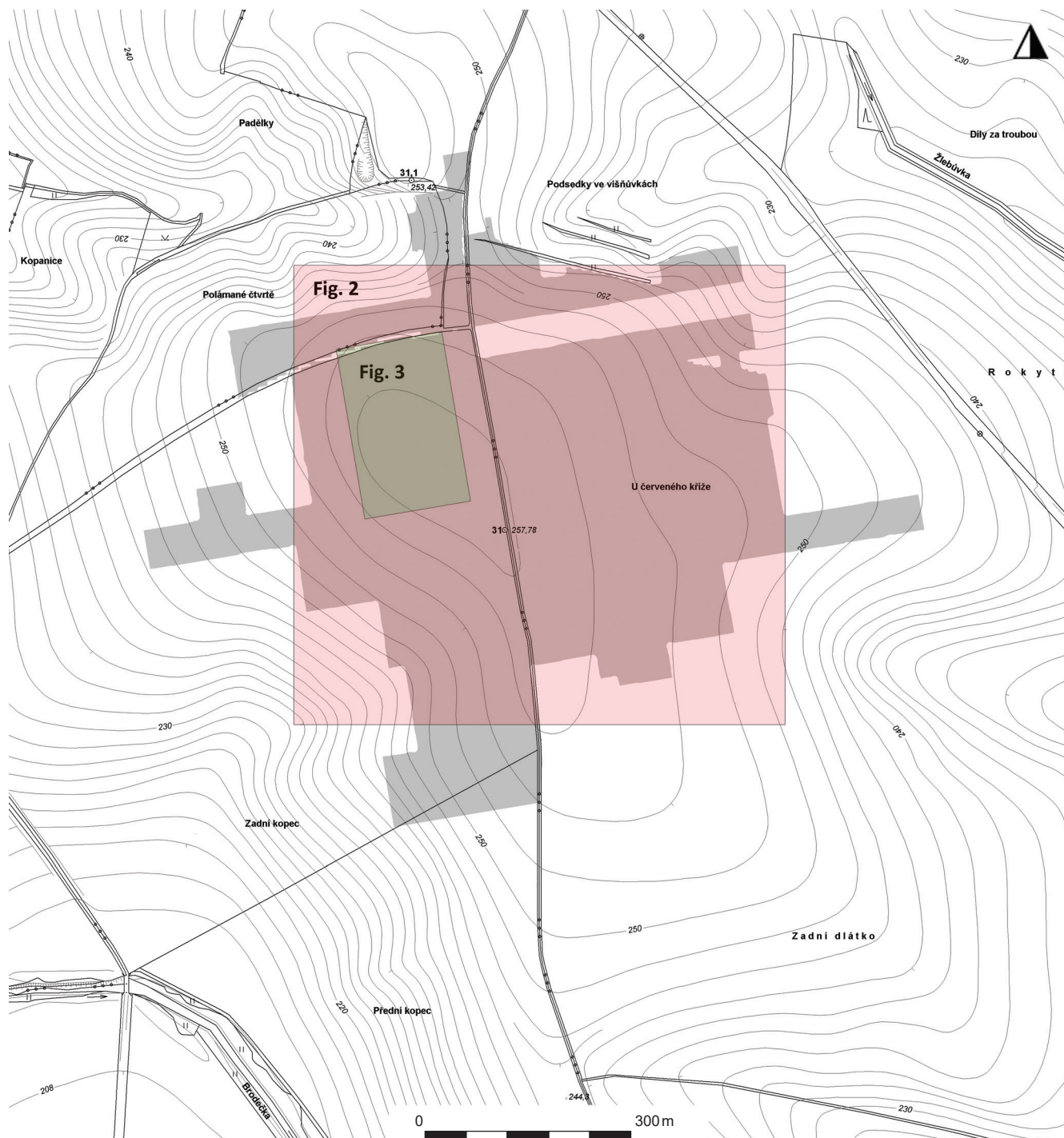


Figure 1. Plan of area of magnetometer survey on contour map of site indicating segments of survey results shown in article as Figure 2 (approximate extent of central part of site) and Figure 3 (repeated detailed measurements).

provided (among other things) a valuable opportunity to gain a closer understanding of several selected archaeological situations visible in the large-area results of magnetometer measurements. The aim of this article is to provide archaeologists and specialists using various natural science methods in archaeology with a comparison of the results on non-destructive geophysical survey and archaeological excavation. Thanks to this comparison, in the case of the Němčice site, we will be better able to predict the most probable origins of measured anomalies, interpret situations in various parts of the area, and also formulate the purpose of individual situations or alternatives to the ways various types of features were abandoned.

3. Objectives and employed methods

Another aim of the new archaeological project was to try to verify the origin of selected archaeological situations identified earlier by geophysical methods, their dating and, based on this information, to assess the importance, various functions and activities at the unique site. Even if additional geophysical measurements in the area were not planned in the project, new questions also required the inclusion of separate geophysical measurements, namely for the precise localisation of prospective situations for the effective placement of verification test pits and the verification of the character of fills of previously-investigated situations. The part of the central area of the site southwest of the crossroads of field paths was therefore repeatedly measured in 2021 with an even more detailed collection of measured data at a density of 0.25×0.1 m (Křivánek, 2022). A five-channel DLM-98-ARCH fluxgate gradiometer on a two-wheel frame with five FMG650B sensors (Sensys, Germany) was used for the repeated small-scale measurements. In the uncovered situations in 2022, a detailed measurement of the apparent magnetic susceptibility was also carried out on selected suitable vertical sections (Křivánek, 2023, in print). A SM-20 magnetic susceptibility meter (GF Instruments, Brno) was used for the small-scale measurement in a 0.1×0.1 m grid.

4. Summary of results of large-area geophysical surveys

The geophysical surveys of the Němčice site were based on the previous positive experiences from other applications of geophysical methods in the surveys of sites from the La Tène period (e.g., Křivánek, 2004; 2017; Křivánek *et al.*, 2013), as well as their possible local application during archaeological excavations (Dalan, 2008; Křivánek, 2008; 2016b). Today we already have several examples of various large-area geophysical surveys at La Tène sites, often also in close cooperation with archaeologists and with the use of materials from archaeological excavations (e.g., Deberge and Dabas, 2009; Holzer, 2009; Milo *et al.*, 2015; 2016; Fassbinder *et al.*, 2018; Frank-Danielisová *et al.*, 2018; Goláňová *et al.*, 2021; Maté-González *et al.*, 2021, *etc.*).

In the case of the Němčice site, an area of 44.31 ha was investigated by large-area magnetometric surveys in 2002–2012 (a part of the central area of 3.77 ha was examined repeatedly with two types of magnetometers in 2011 – Křivánek, 2012). The result of the magnetometer survey confirmed the large extent of the inhabited part of the site, which can include not only the hill in the “U červeného kříže” area, but also parts of the adjacent sloping terrain in the “Polámané čtvrtě”, “Zadní dlatko” and “Zadní kopce” areas (Figure 1). The complete magnetogram has been published several times (see Křivánek, 2014, Figures 5, 6 and 7; 2016a, Figures 8 and 9; or also Trebsche 2020, Figure 3.15). We can consider the area of the hill, of around 30 ha, as the central part of the larger site from the La Tène period, where we observe the most distinctive concentrations of various magnetic anomalies on an approximately rectangular plan of 500×600 m. A highlighted section of the magnetogram in the central part of the site reveals many hundreds to lower thousands of magnetic anomalies, including the distinguishing of their possible shapes, dimensions and amplitudes (Figure 2). These parameters and the conspicuously uneven distribution of magnetic anomalies largely predetermine the likely interpretations of different groups and shapes of magnetic anomalies. We can also consider a certain targeted urbanisation of the Němčice site in view of a number of discussions and documented examples of internally-structured La Tène sites elsewhere in the world (Audouze and Buchsenschutz, 1992; Brunaux *et al.*, 2003; Kaenel, 2006; González-Ruibal, 2012; Han, 2016; Méniel, 2016; Ruiz-Zapatéro *et al.*, 2020; Čižmář and Danielisová, 2021, *etc.*). Besides revealing an apparently non-random structure of probably various activities in different parts of the central area of the site, the magnetometer measurement results so far have not confirmed any relics of perimeter fortifications or an enclosure. The Němčice settlement and production area was evidently not fortified. Compared with other types of archaeological surveys (surface collections, detector surveys), the distribution and type of magnetic anomalies make it possible to preliminarily predict various types of activities in different parts of the central area (structured settlement, specialised production activity – Křivánek, 2016, other activities – Křivánek, 2019). The identification of several smaller ditch enclosures also indicates other activities in the central part of the site (of a ritual or funerary character – for similar interpretations see Brnič and Sankot, 2005; Mazáč, 2019, Vávra and Beneš, 2020, *etc.*). At least five square enclosures, one circular enclosure and two indications of relicts of rectangular enclosures were delineated, thanks to the more detailed repeated measurement in 2011 (Křivánek, 2012) when narrower perimeter grooves as well as several small separate situations inside small enclosures were reliably delineated (Figure 3a, b). This foundation for the detailed differentiation of situations in the central part of the site became the initial basis for the selection of situations suitable for archaeological verification in the new project (Figure 3c). The order of marking the areas of the trenches (area 1, 2 and 3) respects the markings in the archaeological documentation.

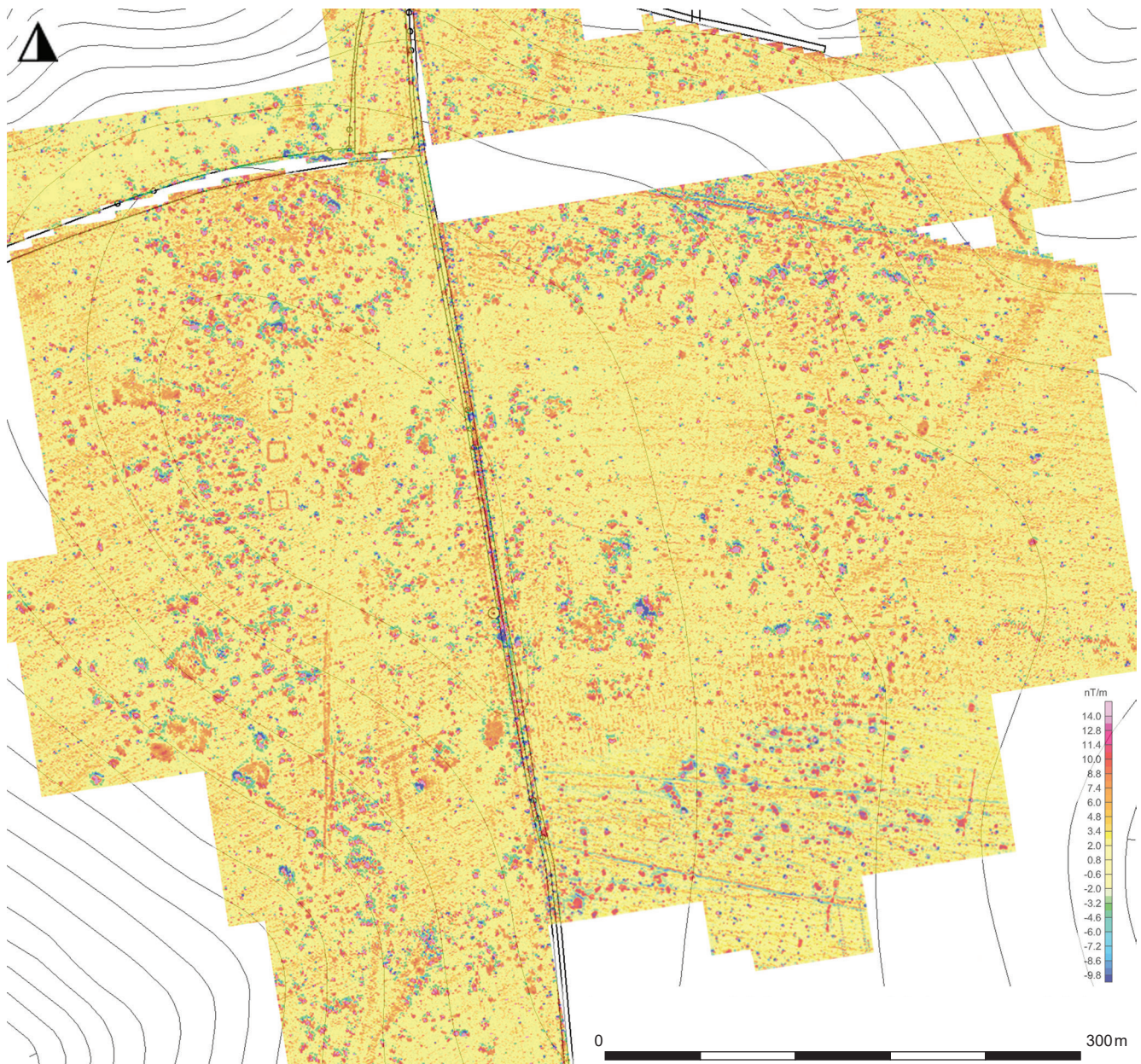


Figure 2. Result of large-area magnetometer survey above central part of site on contour map.

5. New geophysical measurements and archaeological excavation

The newly-focussed, detailed and supplementary geophysical measurements in 2021 and 2022 were initiated by planned or ongoing archaeological excavation in the project. In the central part of the site southwest of the crossroads of field paths, an area of 65×95 m was repeatedly subjected to detailed magnetometer measurements in 2021; the aim was to provide an accurate foundation for the archaeological verification of a group of sunken features with varying magnetic qualities. By comparing the highlighted section of the magnetometer measurements with the result of the archaeological excavation and the orthophoto of the test pit from the same year, we were able to confirm the coincidence of the magnetic anomalies

with the locations of the uncovered features, but also the locally different shape or function of individual subsurface situations (Figure 4a, b, c). At the location of the strikingly rectangular and most distinctive magnetic rectangular anomaly, a large and as yet uninterpreted Middle La Tène deep pit (feature 510) with a magnetic filling was uncovered (a location associated with a specialised manufacturing activity). As a result of the magnetometer measurement, the smaller features 512 (storage pit from the Middle La Tène period), 513 (storage pit of the Lusatian culture) and 514 (sunken hut from the Middle La Tène period with evidence of amber production with subsequent complete extended excavation in 2022) were also distinguished in the vicinity of feature 510 (Čižmář *et al.*, 2023). The fillings of these features apparently were not uniform; distinctive magnetic

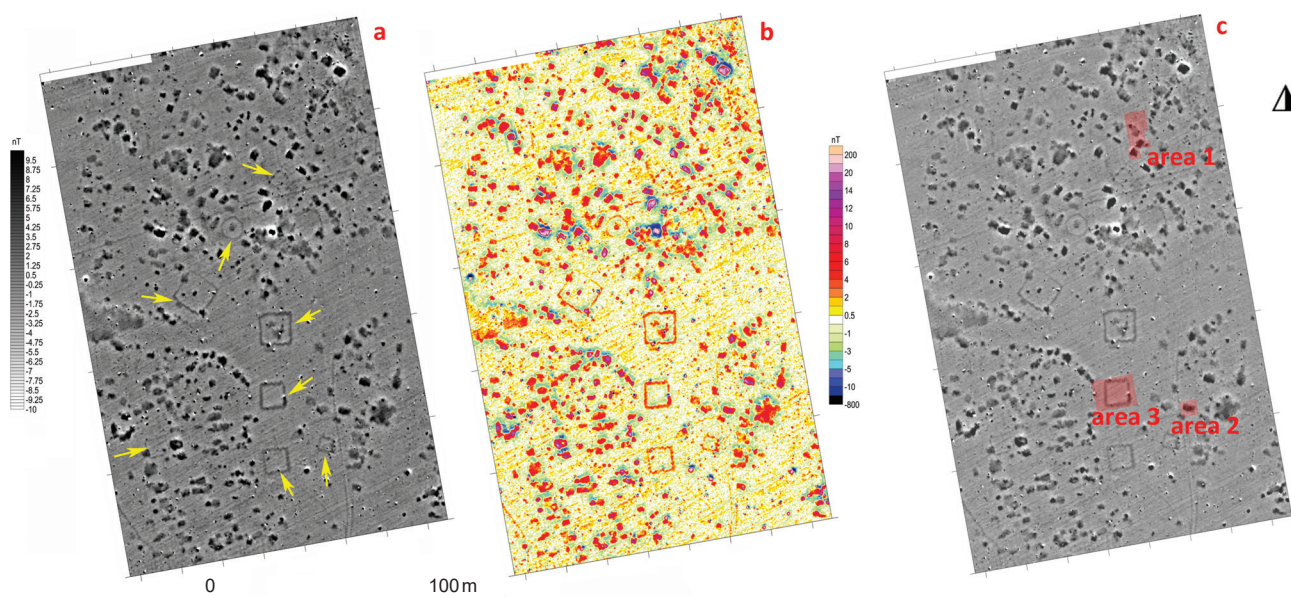


Figure 3. Detail of 2011 repeated detailed magnetometer measurement in black and white (a) (small ditch enclosures indicated by arrows) and colour (b) display scale and section of same area with new archaeological excavations marked (c).

manifestations appear primarily above features 513 and 514 at the edge of the excavated area in 2021. For other uncovered situations one metre or several metres deep, we observe substantial differences in the magnetic fillings of the features. The square, sunken feature 503 (hut from the Middle La Tène period) and adjacent smaller oval feature 507 (Lusatian culture pit) showed only a very weak magnetic anomaly of a different shape than the actual uncovered floor plans of the features. Only the superposition of smaller feature 511 (a shallow circular pit filled with daub) is distinguished by a more pronounced magnetic filling and an oval anomaly. In contrast, another oval anomaly adjacent to this situation

(above another pit – feature 500) is highly pronounced. This anomaly respects and even extends beyond the area of the exposed feature and is apparently evidence of the highly magnetic filling of the pit, which contained numerous pieces of daub in a range of sizes. Even in the small area of the archaeological test pit from the year 2021 we therefore encounter groups of sunken features which undoubtedly do not all have the same fillings and therefore probably did not have the same purpose or use.

Other interesting situations were chosen for archaeological excavation in 2022. A large-area excavation over one of the smaller square ditch enclosures identified by magnetometer

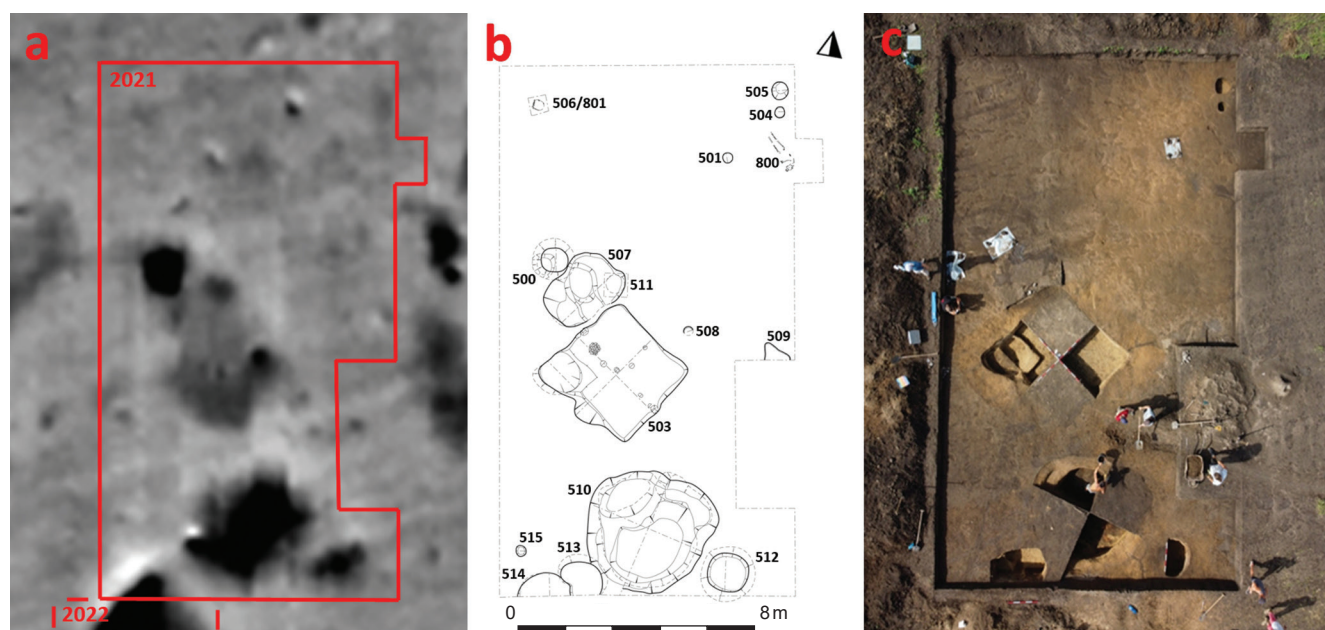


Figure 4. Area 1. Comparison of detail of magnetometer measurement (a), plan of features from 2021 test pitting (b) and orthophoto of excavation (c).

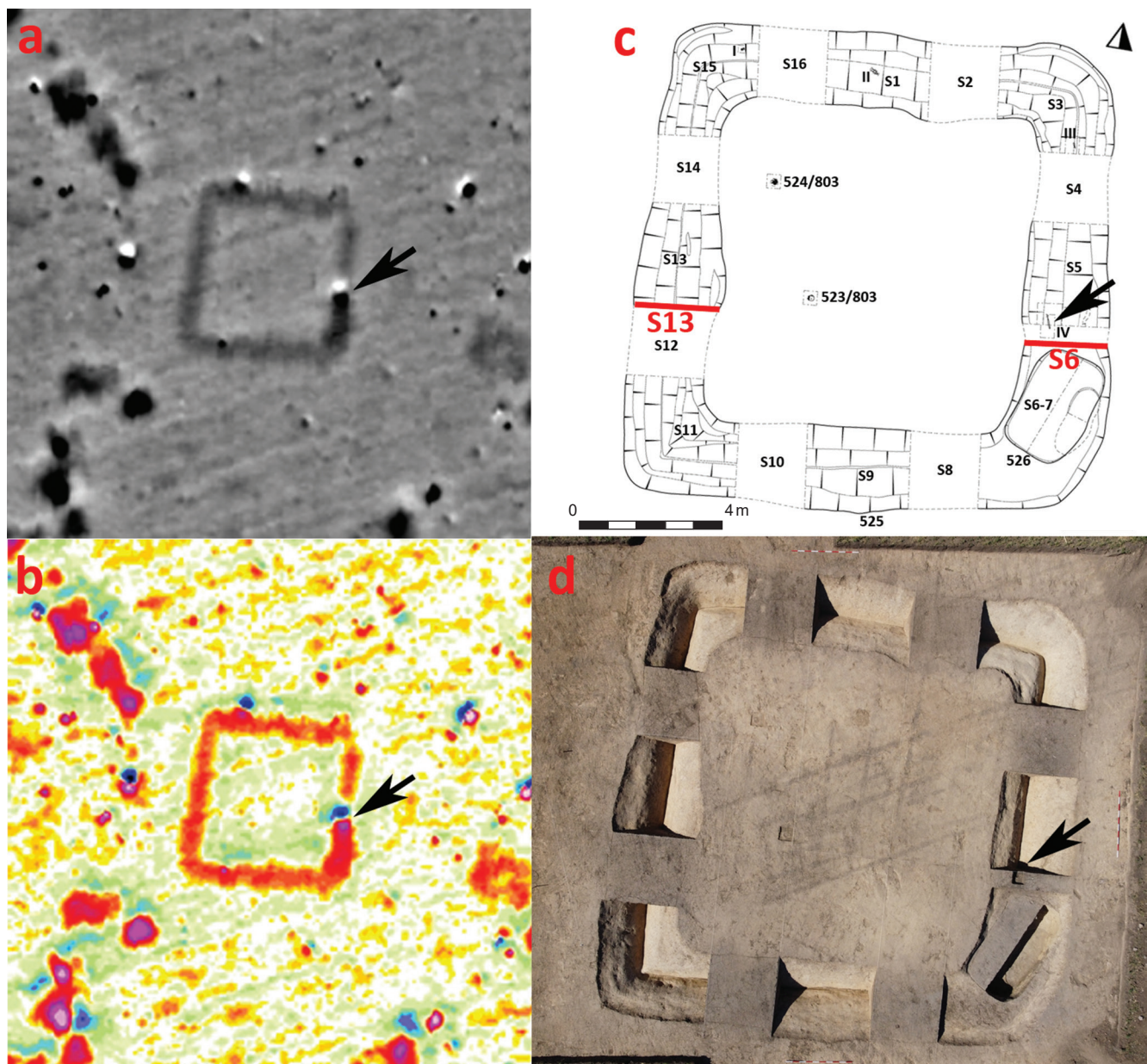


Figure 5. Area 3. Comparison of detail of magnetometer measurement in black and white (a) and colour (b) display scale and plan of test pit of square ditch enclosure (c; locations of two sections S6 and S13 measured with magnetic susceptibility meter marked in red, location of iron sword marked with arrows) and orthophoto of excavation (d).

unequivocally confirmed a La Tène dating and the likely ritual function of the enclosure. Several iron artefacts (parts of swords and spears) were among the interesting finds in the inner part of the ditch. It was only after a detailed revision of the magnetometer measurement result and the display of the data in a colour scale that the point dipolar magnetic anomaly was sufficiently distinguished in the places above the interface of the eastern excavation sectors S5 and S6, from where an iron sword (the largest of the obtained artefacts, arrow in Figure 5a, b, c) was retrieved from the ditch. If even a relic such as an iron artefact with a clear link to the demise of the ditch enclosure can be identified in the result of the detail of the magnetometer measurement, what origins can other dipolar anomalies have in the vicinity of

the enclosure and in other investigated areas? Of course, we will encounter recent disturbing metals in the topsoil, but in several other ditch enclosures at the site there are apparently very similar anomalies (*i.e.*, metals) in the ditches (perhaps in their fillings). This could be good news about the metals still present in the fills of archaeological situations or, more generally, unploughed subsoil.

The exposed situation of the square enclosure was also used for additional detailed measurements of apparent magnetic susceptibility *in situ* by magnetic susceptibility meter. Two vertical sections were measured in the eastern sector of S6 and the western sector of S13 (Figure 5c), and in both cases, the result of the distribution of the apparent magnetic susceptibility was compared with the

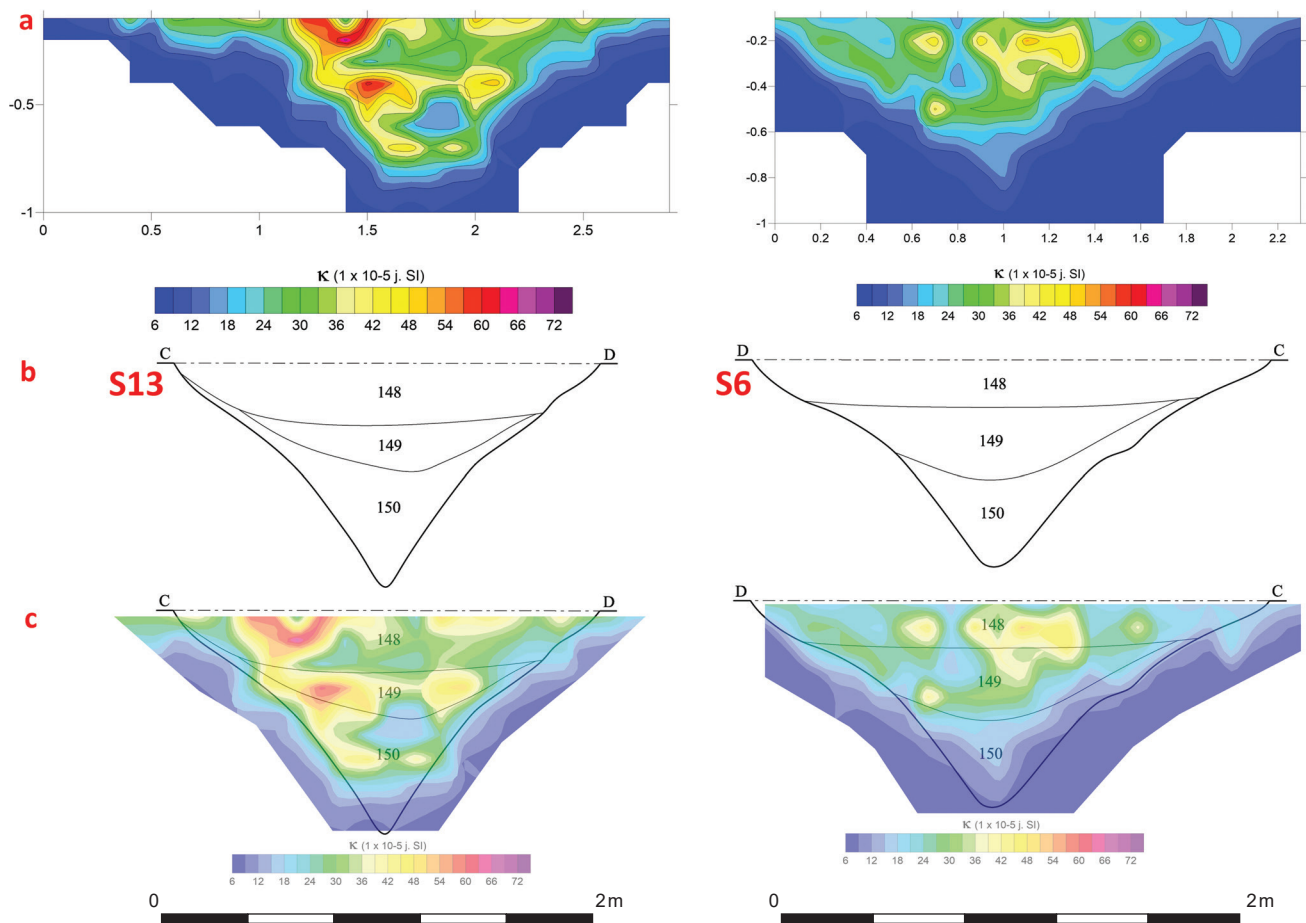


Figure 6. Area 3. Measurement result of apparent magnetic susceptibility on vertical sections S6 and S13 of square ditch enclosure 522 (a), archaeological documentation (b) and combination of both results to differentiate different layers in ditch fill (c).

archaeological documentation (Figure 6a, b), where at the common intersection we can observe agreement with the differentiation of the various layers of the ditch filling (Figure 6c). In the western sector of S13, the filling appears to be generally more magnetic than in the eastern sector of S6, but the stratification in both sections is nearly identical. Layers of greyish-brown, moderately-settled silty soil (148 and 149 in Figure 6c) are the more magnetic layers of the ditch filling, while the values of magnetic susceptibility also decrease with depth. This may be related to the greater number of finds and pieces of daub only in layer 148. The layer of light greyish-brown, settled silty soil mixed with loess with a minimum of finds in the lowest part of the ditch (150 in Figure 6c) is the least magnetic.

In 2022, however, other archaeological test pits verifying other types of situations (or other types of magnetic anomalies) were also uncovered. These included the excavation of a quarter of the sector of the large and deep storage pit (feature 525). An additional detailed measurement of the apparent magnetic susceptibility *in situ* by kappameter on the south and west walls of the uncovered northeastern sector of the storage pit (Figure 7a, b) was intentionally conducted to compare the character of the filling of the settlement feature with the filling of the

square enclosure. In the common result of the magnetic susceptibility measurement on both adjacent vertical sections, we see a significant difference in the character and homogeneity of the storage pit fill (Figure 7c). The filling of the settlement feature is significantly different and less magnetically homogeneous than the filling of the small square enclosure. In the common overlap of the archaeological documentation and the result of the magnetic susceptibility measurement, we observe a much greater dispersion of materials of varying magneticity in the storage pit filling (Figure 7c). Somewhat surprising is the strikingly similar appearance of the topsoil layer and the brown, moderately-settled silty soil with a small number of daub pieces and other clay lenses (100 and 145 in Figure 7d), which could indicate very similar mixed material from the topsoil in the upper part of the storage pit as well. The layers of light ochre, settled silty soil and dark greyish-brown ashy soil, and the lower, orange-like, burnt, settled daub layers show much higher values of magnetic susceptibility (178, 179 and 180 in Figure 7d). The middle part of the storage pit filling is composed of substantially different and partially burnt material and it is not certain why the situation does not appear as more continuous layers with high values of magnetic susceptibility; it may be locally larger and

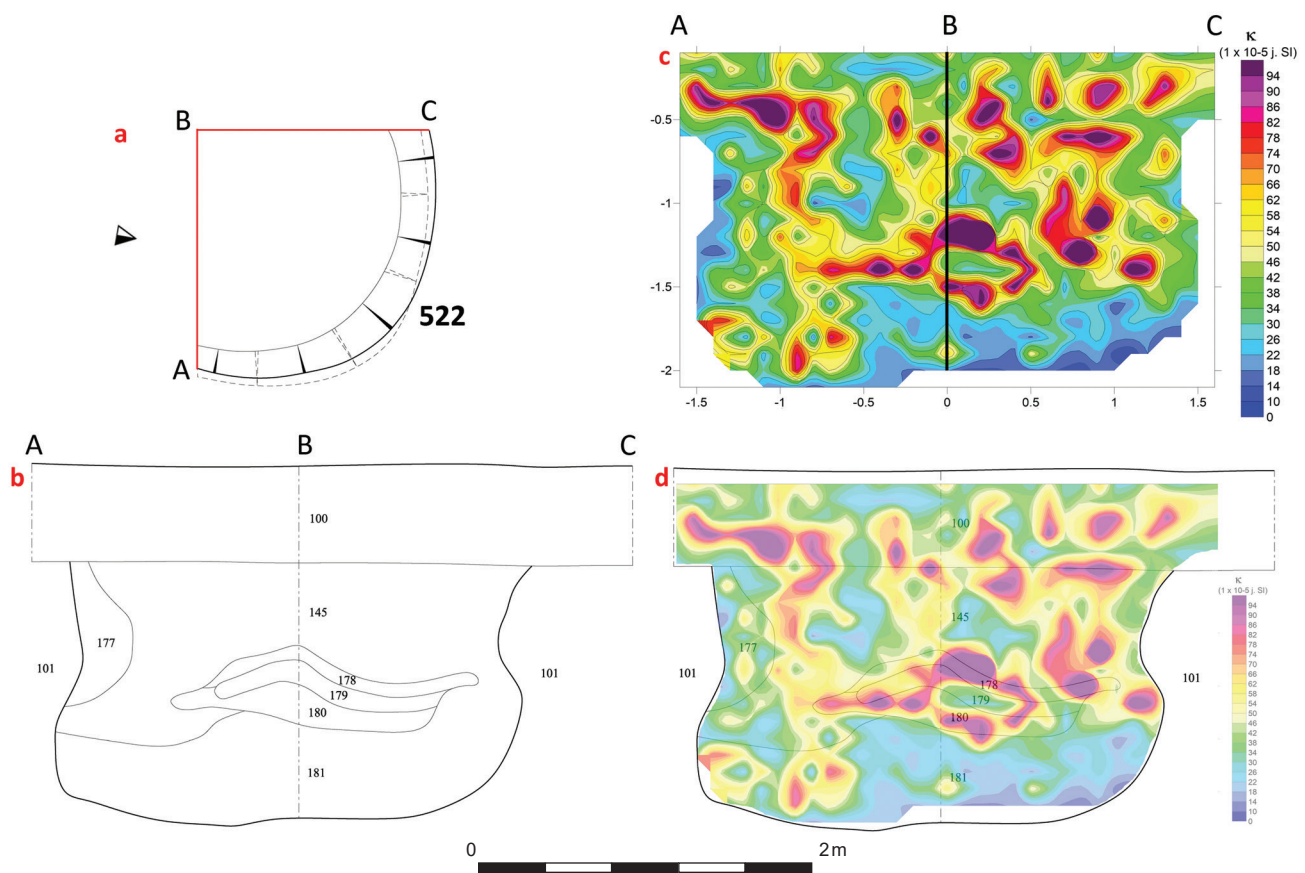


Figure 7. Area 2. Archaeological documentation on vertical sections of uncovered quarter of storage pit 525 (a, b), measurement result of apparent magnetic susceptibility (b) and combination of both results to differentiate different layers in the fill of settlement feature (c).

smaller accumulations of materials of varying magneticity. Although, according to the description, the lowest parts of the storage pit are composed of brownish-grey, loose soil clay with pieces of charcoals or occasionally with daub (181 in Figure 7d), as a result of the measurements with the kappameter, this layer is the least magnetic of the entire filling of the storage pit and is significantly different from the layers in its middle part. One of the reasons for the difference in measured values may be the gradual filling of the storage pit with different materials.

6. Discussion

The results of new archaeological test pits in the central part of the Němčice site indicate the still untapped potential of the results of the large-area magnetometer survey. Targeted situations on the magnetogram were mostly positively verified by archaeological excavation. However, the documented shapes of uncovered features and the shapes of magnetic anomalies show local differences, which may be related to the nature of the features' fillings, their function and, naturally, the state of subsurface preservation in the subsoil. The relatively strong contrast of various magnetic

anomalies at the extensive site is probably due to very suitable conditions for magnetometer measurements. The subsoil of the site is formed by magnetically homogeneous loess with minimal magnetic horizons (the subsoil here consists of a compact layer of uniform loess without other anomalies). On the other hand, the topsoil horizon shows values of magnetic susceptibility several times higher, which is manifested in positive magnetic anomalies of higher nT units in the case of any sunken features in the loess subsoil and filled mainly with topsoil. The height of the magnetic amplitudes in the magnetogram then makes it possible to preliminarily distinguish the fillings of subsurface situations with a higher share of burnt materials or places directly connected to production activity. Subsurface features with partially burnt materials exhibit positive magnetic anomalies that even exceed +10 nT. Relics of burnt situations, production features or production waste (depending on the state of subsurface preservation and the thickness of the situations) can be manifested as magnetic anomalies even in the first few tens of nT, which are accompanied by negative anomaly edges. It will be possible to use the results of detailed magnetometer measurements for the selection of suitable magnetic situations for verification in future archaeological excavations.

7. Conclusion

The position, extent and composition of anthropogenic activities at the central agglomeration of Němčice is extraordinary. The unfortified site located in central Moravia on a significant plateau with long-term agricultural use is of significant supra-regional importance, which has been known now for nearly two decades, mainly thanks to intensively-applied, non-destructive methods of archaeology. The new possibility of comparing the results of one non-destructive method of geophysical survey and the results of archaeological excavation moves the possibility of learning about a site from the realm of preliminary interpretations to real and datable archaeological situations and activities. And while the superiority of destructive archaeology is clear and irreplaceable here, large-area non-destructive methods including magnetometry undoubtedly play a role in the effective implementation of archaeological excavations and without which it would not be possible to focus the excavations on situations based on pre-defined questions. The presented examples of comparison should also prove that systematically conducted detailed geophysical methods can also play a complementary role in the course of archaeological excavations themselves.

Despite the large volume of magnetometer measurements, we still cannot consider the demarcation of the site as definitive, as large sections of areas adjacent to the central part of the site have yet to be explored. With current knowledge of the nature of the activities, the thickness of the cover or the type of subsoil of archaeological situations, it is also possible to consider the possible use of other geophysical (geochemical and other) non-destructive methods. Selected situations and groupings of magnetic anomalies could also be verified, for example, by geoelectrical resistance or radar measurements. We could, for example, track possible local accumulations of stony material or the thickness and condition of features buried in the subsoil. In addition to detailed measurements of changes in apparent magnetic susceptibility *in situ* in open archaeological situations, new possibilities for absolute field or laboratory measurements of volume magnetic susceptibility or monitoring of changes in the filling of features with the study of several depth ranges (Multi Kappa) are also offered today. The use of various environmental natural science methods certainly has great potential in the case of future excavations at the Němčice site.

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