

# Magnetic survey in the process of large-scale construction sites

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## Abstract

Archaeogeophysical prospection is necessary when planning large constructions. Motorized magnetometry systems offer an effective method to identify archaeology prior the construction. A sufficiently large area must be surveyed to estimate the archaeological potential correctly.

## Keywords

archaeological prospection; development-led; evaluation; magnetometry; preventive archaeology

## Introduction

In the past, non-destructive archaeological methods were often considered a supplement to archaeological investigations. In the last 20 years, these methods have crystallized into a separate discipline - archaeological prospecting also in Central Europe. The claim that through non-destructive prospecting, we can find out “little” about a “large” area has thus long been invalid. It is especially true in development-led (rescue) archaeology, where conducting and managing archaeological excavation has become an incredibly complex task. A tight schedule, limited human resources and, finally, a limited budget are usually the main characteristics of such projects. Thus, the application of archaeological prospection methods has become necessary when planning large constructions.

Estimating the cost of the research is usually the first reason for using non-destructive prospecting methods (literature and map searches, field visits, aerial photography). In combination with GIS analyses, these well-established approaches will significantly improve the chances of getting the construction schedule right and estimating the cost of the archaeological investigation.

However, conventional methods often require a more extended timeframe for successful implementation. Despite the undeniable advantages, the picture provided by these traditional methods is often limited and time-consuming, especially in the case of field surveys. It is usually

not possible to systematically cover the whole area; thus, we create gaps. As development-led archaeology is usually under an obligation to investigate the entire archaeology due to the threat of destruction, these areas pose a potential risk from both an investor and conservation perspective. At this point, archaeogeophysical prospection usually comes to the rescue. In the context of extensive construction sites in the open landscape, the motorized magnetometry systems offer a rapid and effective method to fill the blank areas.

Despite many surveys and publications presenting their results, only a few studies critically evaluate geophysical prospection's contribution to rescue archaeology. The absence of studies comparing the results of geophysical prospection and archaeological research is significant. In the paper, we compare the interpretation of the magnetic survey with the results of the archaeological excavation. The aim is to gain an understanding of the relevance of prospection and to identify the limitations and benefits of prospection for rescue archaeology.

## Results

In cooperation with archaeological and heritage management bodies and investors, we analyzed data from several

development-led projects in the Czech Republic. The aim was to estimate the success rate of magnetic prospection and quantify the main factors influencing prospection's ability to detect archaeological situations successfully. We understand the success or effectiveness of prospection as the degree of agreement between the results of archaeological research and magnetic prospection. However, the overall contribution of prospection to the knowledge of the investigated site was also taken into account when evaluating effectiveness, for example, identifying its nature, extent or density and type of archaeological features.

In our work, we proceeded from the assumption that the results of geophysical prospection cannot be fully verified by archaeological excavation, as the latter is mainly subjective and interpretive.

In contrast, geophysical prospection is non-destructive, allowing the process to be repeated and reconstructed. The results themselves are objective and only gain subjectivity through interpretation. Therefore, the results of the prospection cannot be verified by archaeological research but only compared (Löcker et al. 2015; Seren et al. 2013).

The success of prospection largely depends on the appropriate combination of the geological subsoil and the nature of the archaeological objects. While the analyzed dataset does not cover the full spectrum of possible variations in the geological setting, the sites are located in locations common to anthropogenic activity, represented by the settlement and funerary features.

To determine the level of agreement, we used manual qualitative comparisons of the results and quantitative statistical methods: the kappa agreement index (a measure of agreement between categorical variables – excavated and interpreted) and the spatial correlation method (David et al. 2008; Linford and David 2001). All spatial analyses were conducted in a GIS environment.

We identified three main factors that influence the effectiveness of prospection:

- Spatial inaccuracies - misidentification of object position or anomalies
- Geological and pedological environment
- Morphological characteristics of objects - dimensions, shape and depth, state of preservation.

From the settlement objects category, magnetometry correctly identifies all archaeologically documented earthworks, settlement pits, hearths and kilns. Objects of a funerary type were significantly under-represented in the sample compared to the other objects. Geomagnetic

prospection could identify only significant structures, such as a grave with a circular ditch, chamber graves, or extensive burial grounds.

## Discussion


Based on our experience from these and other projects, it can be concluded that the problems that have arisen can be solved successfully. Spatial inaccuracy is an error that arises during data processing, excavation, or prospection. Nowadays, however, thanks to the availability of modern instruments, it can be easily eliminated.

A challenging or unsuitable geological environment is essentially the biggest issue for magnetometry. Due to the presence of ferri-magnetic minerals in the soil, it is usually impossible to detect archaeological objects. Sediments (alluvial or fluvial) are often an obstacle impossible to overcome for geophysical methods. However, this handicap can be overcome by large-scale prospection of the surrounding area and estimation of the archaeological potential of the site. Moreover, geological structures are sometimes only manifested locally. Some archaeological features, such as ditches, channels, trenches, and exploitation pits, have significant shapes and dimensions, and their identification is relatively simple. However, a sufficiently large area must be surveyed for their correct interpretation. In addition to the spatial extent of the object, the depth or preservation of the object is also important. Detection of shallow objects is very problematic, especially during mechanical topsoil removal. In most cases, the detected objects were almost half as deep as those that the magnetometer could not detect.

## Conclusion

The results of the comparison demonstrate the advantages of archaeogeophysical prospection conducted prior to the excavation itself. Large-scale magnetometry significantly helped field archaeologists and investors plan archaeological excavation and construction work in advance and create a convenient time-schedule for both groups. Besides cost and time savings, integration of archaeo-geophysical prospection into the planning process points out several weaknesses of the traditional excavation method used in development-led archaeology.

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