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Piotr Wroniecki  

**Discovery of new Iron Age groove-type features from Michałowice in 2010. A geophysical case study**

**Abstract:** The archaeological site in Michałowice is located in south-eastern Poland within the Świętokrzyskie Voivodeship, Czarnocin commune. It is thus far the only known site with over a dozen excavated groove-type burials attributed to the Roman Iron Age of the Przeworsk Culture. In 2010 a small geophysical test survey was commissioned encompassing an area of 50×30m. Amongst the many geophysical techniques available for such an investigation, the magnetic method was chosen. The aim of the survey was first of all to test whether the local archaeological features that were assumed to exist within the site, such as groove-type square burial enclosures, urn graves and possible settlement pits or even anthropogenic sediments, would generate a clear, interpretable geophysical anomaly. For this purpose a Bartington Grad601-Dual fluxgate gradiometer was used. Data was collected in parallel traverses with 1×0.12m sampling and within one 30×30m and one 20×30m grid. The systematic analysis and mapping of the anomalies registered with magnetic prospecting confirmed the presence of buried archaeological structures, revealing new details of the Michałowice sepulchral complex. Although the study area was relatively small, the amount of new information acquired from the survey was overwhelming. What came as a surprise is that all of these anomalies were located in an area presumed to be a peripheral part of the archaeological site. Thanks to the experiences of the 2010 survey, the capabilities of the magnetic method on this specific site have been thoroughly investigated and evaluated positively. For now, a basic modus operandi for interpreting magnetic data for Michałowice has been created, which hopefully will serve as a roadmap or reference for future integrated non-invasive approaches in the region.

**Keywords:** Michałowice, archaeological geophysics, non-invasive archaeology, magnetic prospecting, groove-type features

1. **Introduction**

The archaeological site in Michałowice is located in south-eastern Poland within the Świętokrzyskie province, Czarnocin commune. Based on the current level of archaeological knowledge it is the only intensely studied site to date with over a dozen excavated groove-type burials (Zagórska-Telega, Pikulski, Bulas, Szczepanek in this volume) attributed to the Roman Iron Age of the Przeworsk Culture.
The current knowledge of the chronological and spatial components of the site is based on data collected during many seasons of the Jagiellonian University Institute of Archaeology excavations led first by Jacek Poleski (in 1982), Piotr Kaczanowski (in 1990–1991) and subsequently by Jacek Pikulski and Joanna Zagórska-Telega since 2008 (Kaczanowski, Madyda-Legutko, Poleski 1984; Zagórska-Telega, Bulas, Pikulski, Szczepanek 2011). During these years, amongst other features, an untypically large collection of groove-type enclosures has been uncovered. All of these features form a chronologically, spatially and culturally coherent set making Michałowice the largest cluster of such features in Poland. These square burial enclosures, however, are not a rare find themselves, as they are regularly excavated in various other contexts but never in such concentrations. What ultimately makes the Michałowice site unique is mostly the closeness and amount of groove-type burials, causing some to call it an Iron Age necropolis. The reason for this archaeological abundance is as yet unknown. Whether it is caused by a good state of preservation or maybe because of other more elusive factors such as past burial rituals is still a subject of debate.

In 2010 a small geophysical test survey was commissioned. It was carried out by Piotr Szczepanik and Piotr Wroniecki and encompassed an area of 50×30m. Amongst many geophysical techniques available for such an investigation, the magnetic method was chosen (Aspinall, Gaffney, Schmidt 2008; Clark 2000; Gaffney, Gater 2003; Kvamme 2006; Scollar et al. 1990). The aim of the survey was first of all to test whether the local archaeological features that were assumed to exist within the site (such as groove-type square burial enclosures, urn graves and possible settlement pits or even anthropogenic sediments) would generate a clear, interpretable geophysical anomaly and, secondly, to attempt to acquire new data regarding the spatial components of the site.

2. Magnetic method

Since the 1950’s when Martin Aitken (1958) first successfully located archaeological features (Romano-British kilns) with the use of a proton magnetometer and subsequently proved that certain archaeological features generate their own, small magnetic field, magnetic surveying has become a widely established and effective tool of non-invasive archaeological prospection.

Magnetic survey relies on the presence of the Earth’s natural magnetic field for the source of its signal and also on the local variation of the magnetic field which may be caused by anthropogenic factors such as firing, or for instances of the infilling of abandoned ditches with a different soil type. The Earth’s magnetic field is measured in units of nanotesla (nT) and on average has a strength of about 30,000 nT and may vary significantly (up to even 60,000 nT on the northern magnetic pole) depending on where it is measured (Kvamme 2006, 209). This fact is crucial in demonstrating how subtle and precise magnetic measurements have become since most potential archeological features cause an anomaly on average within 0.5–5 nT compared with the main field.

Amongst the vast arsenal of geophysical and non-invasive prospecting techniques (vide Kuna 2004), the magnetic method was chosen due to three factors: speed, sensitivity & local soil conditions. As a passive method, magnetic survey does not require direct contact with the soil, allowing for rapid data acquisition numbering in the hectares per day. Geologically, the study area is dominated by loess soils, which are mostly non-magnetic. It is to this that we owe high
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detection rates, as the fills of archaeological features, even if not strongly magnetized, often create a very clear contrast with the surrounding non-anthropogenic soil. One of the most successful examples from Poland of the large cognitive possibilities of magnetic prospecting on loess soils is the geophysical survey of Słonowice (Herbich, Tunia 2009).

During the 2010 magnetic survey in Michałowice, a 50×30m study area was set up. A Bartington Grad601-Dual fluxgate gradiometer (Bartington, Chapman 2004) was used. Data was collected in parallel traverses with 1×0.12m sampling and within one 30×30m and one 20×30m grid. Grids were staked out with the use of a Total Station and tied in to the national survey grid as well as the local archaeological grid.

Terrain accessibility was high (meadows) allowing for collection of relatively flawless raw data without any staggering or gait. Despite this a slight heading error was observed and was filtered out in the ArchaeoSurveyor software package with the use of the destripe algorithm. The acquired processed data set was interpolated to a 0.25×0.25m matrix and visualized in the 256 shades of grey convention with dark colors symbolizing positive readings and light colors showing negative readings (Fig. 1).

3. Interpretation

The interpretation of the geophysical data was based on observing and describing contrasts between the natural background and visible (possibly archeological) features. Such contrasts are referred to as anomalies. From a methodological point of view, it is wrong to unambiguously attribute them to specific features or chronological periods before verification is carried out. Though exceptions exist to this rule; sometimes anomalies form patterns or shapes that can be interpreted directly and broad chronological

ramification can be estimated based on prior archaeological knowledge and experience. This approach is possible only when it is possible to observe whole features, which are much easier to understand than those that are only partially revealed (Kvamme 2006, 205–206).

Establishing a consistent terminology in interpreting geophysical data is also fundamental and very important for mutual understanding between the surveyor and archaeligist. Geophysical data needs to be described by a two tier system of attributes. The first level of information classifies the shape and response strength and allows only for a basic interpretation of anomalies. For example,
it is permitted to describe an anomaly as a “dipolar, high amplitude anomaly that aligns itself with the main field” and to interpret it as originating from a ferrous item; however it cannot be determined in this stage if this object is actually an archeological artifact or a modern intercalation.

The second level of interpretation is based on correlating magnetic anomalies and patterns to specific archeological features or past human activities. This is rarely possible based on the application of solely one non-invasive technique (magnetic prospecting in this case). It is appropriate for a strategy to be drawn out that would help enhance the possibilities of a second level interpretation. As any remote sensing technique, the acquired (magnetic) image shows only what is detectable by the applied method. Therefore any previously obtained excavation data is always helpful and should be taken into account. Ground-truthing and, if possible, carrying out test trenches over anomalies deemed “interesting” is also a crucial part of building an interpretation and valuating the effectiveness of the applied survey technique.

In order to attempt a successful archaeological interpretation of any geophysical data, a preliminary characteristic of geophysical targets is crucial (Fig. 2). Each of these (based on their supposed state of preservation, depth and fill) will potentially generate a different magnetic signal that could be registered during the survey. Four basic types of archaeological features were deemed of specific importance. A brief characteristic of them was created in order to draw out their possible detection rate and possible magnetic signal that they could generate. These types included a) settlement pits b) square burials c) urn graves with possible ferrous goods and d) skeleton burials.

In an archaeological trench, each feature is visible and differentiated through its specific imprint left in the soil and material culture registered within the features. From a purely archaeological perspective, pit houses will differentiate drastically from the relics of ramparts and middens will be easily discernible from kilns. Each of these features, based on the material culture found within, will often allow one not only to understand the function but also the chronological and cultural ramifications. In a certain way, the situation known to archaeologists from excavations may be conveyed to the realities of interpreting geophysical data. Of course, as with any archaeological technique, the limitations of geophysics (of which the most profound is the impossibility to procure material culture) have to be taken into account in order to avoid over or misinterpretation of data. The foremost limitations are:

- Anomaly shapes do not always correspond to the actual shapes of underground structures,
- The same type of archaeological feature may generate a different response based on their state of preservation or topsoil overburden,
- The positive geophysical record does not have to be representative of the actual archaeological record.

The systematic analysis and mapping of the anomalies registered with magnetic prospecting in 2010 confirmed the presence of buried archaeological structures, revealing new details of the Michałowice sepulchral complex (Fig. 3). Although the study area compared to spatial capabilities of the method was relatively small, the amount of new information acquired from the survey was overwhelming. What came as a surprise is that all of these anomalies were located in an area presumed to be a peripheral part of the Michałowice archaeological site.

From the acquired dataset, the easiest to interpret were anomalies stemming from groove-type burials, as they were clearly visible and discerned on the basis of shape and
alignment with regards to the Earth’s cardinal directions. A total of 4 such features were mapped, the largest of which had an area of \( 15 \times 15 \text{m} \).

Positive point anomalies characteristic of various settlement pits were not registered at all, perhaps owing to a small study area but also due to the distinct lack of any traces of settlement activity throughout the many years of archaeological excavations.

A series of dipolar anomalies (more than 20) of an amplitude ranging ±5nT were also documented. Many places for possible graves were designated, as each dipolar anomaly was potentially, though unlikely, a burial feature. It needs to be noted that only urn and skeleton graves with ferrous (iron) grave goods or shallowly deposited well-fired pottery could be theoretically detected. Hence the acquired magnetic map cannot be treated as a full inventory of this type of archaeological features. Due to ploughing, urn graves and ceramic vessels are usually in an appalling state of preservation, therefore the magnetic data was an important source of information, giving excavators an indication where extreme caution was to be applied during exploration.

A large, oval structure of a radius of about 20m was registered in the southeastern part of the magnetic map. This feature type was an entirely new discovery as it had not been registered earlier through excavation. This anomaly however was not a typical enclosure comparable to the anomalies stemming from groove-type features but clearly a buried stratigraphic unit with a relatively unified magnetic fill.

### 4. Verification through excavation

Results of the 2010 magnetic survey prompted research to wholly adjust the subsequent field campaign of 2011 to study and verify the magnetic anomalies through excavation (Fig. 4). For the purpose of this article, a brief case study of the magnetic signal generated by a selected number of features will be presented (Fig. 5). A precise, purely archaeological analysis of the excavated features is presented in detail in this volume (Zagórska-Telega, Pikulski, Bulas, Szczepanek in this volume).

<table>
<thead>
<tr>
<th>Feature</th>
<th>Possible source of magnetism</th>
<th>Presumed anomaly</th>
<th>Detection rate</th>
<th>Figure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Settlement pits</td>
<td>Magnetic fill</td>
<td>Positive point magnetic anomaly</td>
<td>High</td>
<td><img src="image1.png" alt="" /></td>
</tr>
<tr>
<td>Square burials</td>
<td>Magnetic fill</td>
<td>Square shaped magnetic anomaly</td>
<td>High</td>
<td><img src="image2.png" alt="" /></td>
</tr>
<tr>
<td>Urn graves</td>
<td>ferrous objects (i.e. weapons)</td>
<td>Dipolar anomaly</td>
<td>High, but hard to differentiate from other ferrous detritus</td>
<td><img src="image3.png" alt="" /></td>
</tr>
<tr>
<td>Skeleton graves</td>
<td>Grave goods, fill</td>
<td>Dipolar anomaly</td>
<td>Low</td>
<td><img src="image4.png" alt="" /></td>
</tr>
</tbody>
</table>

Fig. 2. Characteristic of expected archaeological targets in Michałowice
The four square shaped magnetic anomalies shaping interpreted initially as groove-type burials were positively verified (features nr 27, 85, 90, 95). A further square burial was also excavated but had not been visible in the magnetic data (feature 86). This is probably due to the fact that the feature’s fill was not entirely magnetic, making it impossible to discern the characteristic square pattern in the geophysical image.

What was deemed initially as unlikely, a series of urn burials were also positively verified. Feature 80 generated an extremely subtle, barely visible dipolar anomaly generating an amplitude of ±1nT. The source of this anomaly was a partially destroyed ceramic vessel that served as an urn grave. Further urn graves (91 and 92) generated a stronger, clearly visible dipolar anomaly oscillating between ±5nT. Feature 91 consisted of an iron spearhead embedded horizontally into the subsoil. In case of feature 92, the sources of the magnetic anomaly were also ferrous grave goods, amongst them a ritually bent sword.

The large positive circular anomaly visible in the southeastern part of the magnetic map was, due to time constraints, only partially excavated. Unfortunately, this was not enough for an unambiguous interpretation of the anomaly source. Despite the partial verification, at this stage there is not enough data and evidence to precisely specify the feature’s origin. A thorough excavation of this feature is planned for the year 2012.

5. Conclusions

The magnetic survey in Michalowice not only succeeded as a prospecting tool but also contributed to the understanding of the Iron Age site. Spatially, the survey has redefined the accepted interpretation of the burial complex. Geophysics and excavation works have revealed that the extent of
the site needs to be redrawn. The applied research strategy based on the integration of two sources: magnetic prospecting and subsequent verification through archaeological excavations has undoubtedly shown the extremely large cognitive potential of geophysical prospecting in the region. Furthermore, the results are of high importance in the long process of adapting the capabilities of non-invasive techniques to the needs of valuating archaeological sites located in a loess background. The magnetic survey in Michalowice needs to be treated as a (successful) experiment for evaluating buried archaeological resources of a prehistoric burial complex. Similar experiments in various geological and archaeological backdrops should be deemed appropriate.

Recent years have shown a new wave of heightened interest within the Polish...
archaeological community in non-invasive techniques. It can, however, be observed that the biggest advantages of these techniques – integrated approaches – are still far from being commonly implemented. One of the reasons for this situation is perhaps a notable “fear” or even depreciation of non-invasive techniques as not “real” archaeology. Non-invasive techniques are nevertheless not a threat to “traditional” archaeology, but only a means of augmenting it with new data and spatial capabilities that can be procured within lower financial and time requirements.

As the Michałowice case study has shown, close knit cooperation between geophysicists and archaeologists can foster great and unexpected results. An underlying but very important theme of the research in 2010 and 2011 was the attempt to create a mode of conduct for archaeological-geophysical cooperation. Ultimately, the key to achieving such a mutual understanding is not the applied technique, used equipment, its sensitivity or “high-techness” but the human factor. As long as there is good will on both sides, progress is within reach. For an understanding to be cultivated, both sides need, however, to readjust their aims and methods which is not always easy. This problem was fortunately overcome in Michałowice, paving the way for new research possibilities and approaches that go beyond the analysis of buried features and material culture.

Thanks to the experiences of the 2010 survey and 2011 verification, the possibilities of the magnetic method on this specific site have been thoroughly investigated, laying the basis for a future roadmap to interpreting geophysical data on loess soils. For now, a basic modus operandi for interpreting magnetic data for Michałowice has been developed. Hopefully, experiences from Michałowice
will be a cornerstone for the further advancement of non-invasive methodologies in southern Poland. Further non-invasive research in Michałowice is planned to include other techniques such as LiDAR, earth resistance and large-scale magnetic prospecting.

Odkrycie nowych obiektów rowkowych na stanowisku w Michałowicach w roku 2010.
Geofizyczne studium przypadku


Pomiary wykonane zostały z pomocą gradiometru Bartington Grad601-Dual fluxgate, równoległymi pasami z próbkowaniem 1×0,12 m, w ramach dwóch siatek o wymiarach 20×20 m i 30×30 m. Wyniki badań ujawniły obecność podziemnych struktur archeologicznych, wzbogacając o nowe szczegóły naszą wiedzę o zespole sepulkralnym z Michałowic. Choć zbadany obszar był stosunkowo niewielki, ilość informacji pozyskanych podczas rozpoznania geofizycznego jest znacząca. Co jest szczególnie zaskakujące, to fakc, że wszystkie stwierdzone anomalie pochodzą ze strefy, która miała stanowić peryferię cmentarzyska. Dzięki doświadczeniom z rozpoznania w 2010 roku, pozytywnie zweryfikowane zostały możliwości wykorzystania metody geofizycznej w warunkach tego konkretnego stanowiska. Stworzona została też procedura badań i interpretacji danych geomagnetycznych, która będzie mogła służyć, jako punkt odniesienia do dalszych nieinwazyjnych prac archeologicznych w regionie.

References


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