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Creating a new standard: medieval town(s) within a remote sensing perspective

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INTRODUCTION

Recent years in Poland have been marked by spectacular discoveries of medieval towns: Szamotuły (Dernoga *et al.* 2007; Pietrzak and Rączkowski 2009), Nieszawa (Jaworski *et al.* 2013)

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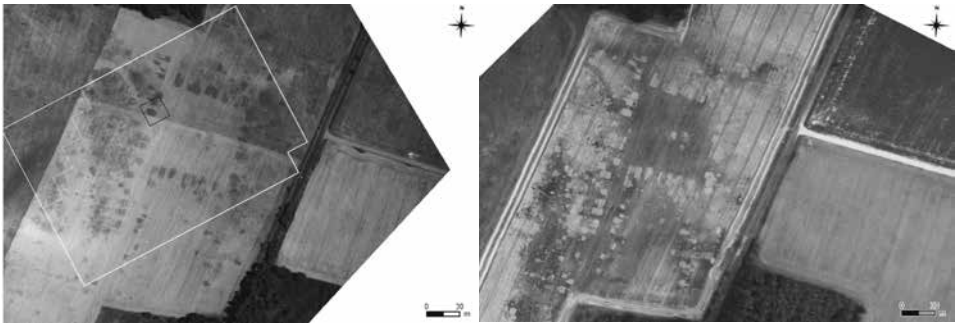

Fig. 1. A – extent of the geophysical prospection marked on a rectified aerial photo from July 2006. Continuous white line – extent of the magnetic survey; dashed white line – extent of the electrical resistivity survey, black line – extent of the GPR tests. B – rectified aerial photo from July 2011

and Dzwonowo (Krzepkowski and Moeglich 2014). In all these discoveries occurring in succession, aerial prospection played an important role. Distinctive differences in the plant cover observed in aerial images, triggered the finds, although each time in different contexts.

In Szamotuły, the search for a medieval church known from written sources necessitated the use of aerial reconnaissance as one of the methods. In 2006, this led to the identification of the entire original town foundation, which had preceded its relocation in a new place in the 14th century. With regard to Nieszawa, historical sources had told the story of the relocation of the town on a new spot in 1460–1462, the political decision being made in an effort to resolve a conflict existing with nearby Toruń since 1424/1425. The original location on the left bank of the Vistula was identified finally by Wiesław Stępień in 2008. And Dzwonowo was discovered thanks to an analysis of vertical aerial images accessible through a geoportal.

Each of these more or less surprising discoveries has confirmed the usefulness of aerial images in archaeology. Their spectacular nature evidently changed the low evaluation of aerial photography that had been current in Polish archaeology (Kobyliński 2005). Moreover, the action undertaken after the discovery of these towns also exceeded current standards adopted by the archaeological and conservation services. Szamotuły were the first to "experience" the new strategy and its application.

AERIAL PHOTOGRAPHY

The search for the medieval church in Szamotuły village started in the 1990s. Trial excavations followed the initial ground surveying, but without satisfactory results. Aerial reconnaissance, introduced as a technique in 2005, produced results already the next year. The spatial foundation of the medieval town was identified, revolutionizing what was known about the town (including its history). The importance of the find triggered widespread interest on the part of the state conservation office, as well as among archaeologists and the local community. Pressure grew to carry out archaeological excavations, the local community considering digging as the only true archaeology and archaeologists perceiving an excellent opportunity for recovering a comprehensive set of artifacts of material culture. The Wielkopolska Province Conservator's Office in Poznań differed in opinion, believing it necessary

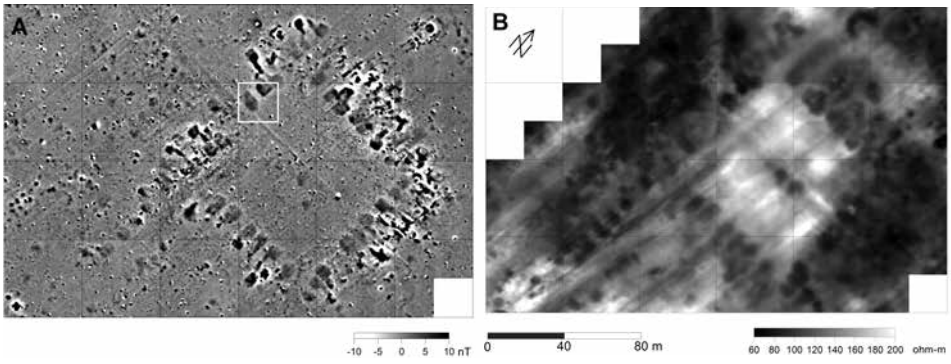

Fig. 2. A - Magnetic map. Fluxgate gradiometer Geoscan Research FM256. Sampling grid 0.25 x 0.50 m, parallel mode. White box - GPR test. B - Resistivity map. Twin probe array, AM= 0.5 m. Sampling grid 1 x 0.50 m

first to inscribe a site of such importance — it was at the time the only medieval city with a layout known to be from the 13th century — as a cultural heritage monument. This required additional data confirming the character of the site (distinguishing features in plant cover observed in aerial images are not considered as binding confirmation of the presence of cultural layers), leading to two test pits being excavated (their location was chosen in effect of an analysis of the 2006 aerial reconnaissance results) (Dernoga *et al.* 2007) and an extensive program of archaeological geophysics.

GEOPHYSICAL PROSPECTION

Geophysical prospection started in the fall of 2006 and was continued with intervals until 2015 (Fig. 1). Magnetic and electrical resistivity methods were applied (in 2006, 2007 and 2013), followed by a radar survey (2009, 2014–2015). All distinguishing features in the plant cover recognized earlier in aerial images were reflected on the magnetic map as anomalies of the intensity of the Earth's magnetic field (Fig. 2A). A number of features recorded as changes of plant cover corresponded to an amplitude of magnetic field intensity values that was much higher than expected of features corresponding to architectural building remains. Falling in the range –30/+110 nT, this high amplitude is generated usually by features formed of strongly burnt materials (overfired clay, ash, slag?). Considering their typical location, usually in the back or central part of individual land plots, they can be considered as remains of features associated with a production of some kind (furnaces?). The marketplace was reflected as an area of fairly stable magnetic field intensity values (changes in the range 2 nT); similarly stable values were recorded beyond the strictly urban zone next to the marketplace. The results of the electrical resistivity survey were similar, although not as clear. Mapping of the ground resistivity results showed up a zone of lowered values (less than 300 ohm-m) corresponding to the architectural zone around the square (Fig. 2B). A series of anomalies characterized by lower values (up to 200 ohm-m) were interpreted as house remains, but the picture of particular features was much less clear than that coming from the magnetic survey. The electrical resistivity results also indicated the presence of features with raised resistivity values (from 400 to 600 ohm-m) in the market place. This could be stone pavement (or gravel?).

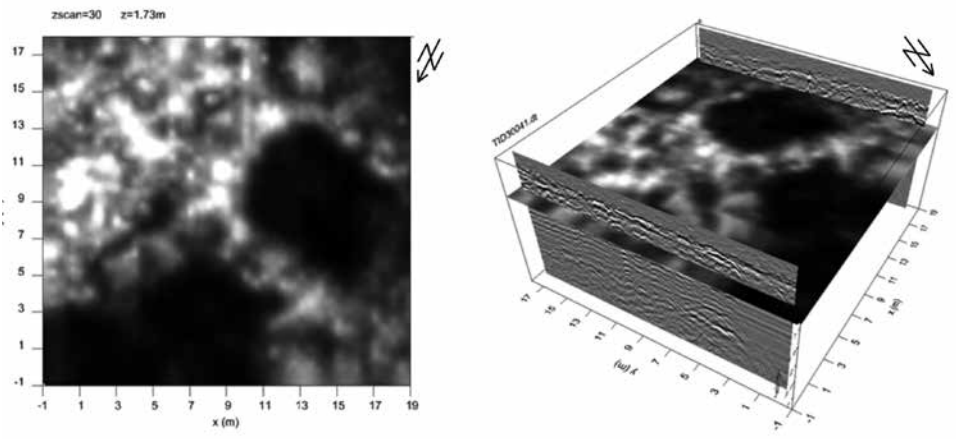

Fig. 3. GPR result in test area. Timeslice, 1.0–1.7m. Data obtained by Gispro, processed by A. Novo Lamoso

Testing by the radar method (2014) gave good results as well, uncovering in the surveyed area two houses that had already been observed in aerial images and confirmed by the results of both the magnetic and electrical resistivity surveys (Fig. 3). Measurements yielded a picture that was just as distinct as that obtained by the other methods, while contributing additional information on the deposition depth of particular layers.

NON-INVASIVE METHODS ... AND WHAT NEXT?

The unique nature of the discovered complex suggested a different approach than that which is used as a rule in Polish archaeology. Further research by non-invasive methods was programmed, the decision being to limit any physical intervention in the cultural layers to the test trenches dug in 2006 (Kijowski *et al.* 2010).

First in line is an aerial prospection of the site. Successive sets of photos will be taken consistently every year in order to identify new features and to create a unique dataset for studying environmental conditions behind the appearance of cropmarks (humidity, crop variety, pests and crop diseases, see Rączkowski 2011). Conclusions deriving from a regular aerial reconnaissance have demonstrated that the cropmarks are not only the effect of an overall humidity balance, but also changing conditions during the vegetative cycle. An apparently good year (projected based on current knowledge, see Wilson 1982) does not necessarily impact clearer cropmarks and *vice versa*. Short-term humidity changes at specific periods of the vegetative process play a significant role as well. Another important observation is that cropmarks not always reveal all the elements of a structure, the parameters of a structure being not the least one of them. It means that feature measurements based on cropmarks may be biased due to local impact of the fill found inside an archaeological structure.

Once the entire architectural zone around the marketplace is tested with the radar method (in 2015), magnetic prospection will continue using different techniques (cesium instruments, measuring total magnetic field intensity). Investigations with the seismic method and soil chemistry analyses are programmed. Research should benefit from the new possibilities provided by LiDAR data, infra-

red photography, satellite imaging, multi- and hyperspectral imaging. Detailed data analyses will permit more extensive understanding of archaeological structures and their spatial interrelation, as well as formation processes, state of preservation etc. The results of these investigations will support decisions concerning site protection principles and project popularization.

A broad range of non-invasive methods applied to the study of the Szamotuły medieval town site will supply data for comparative research on the data itself, supporting critical approaches to the data as much as to the potential and limitations of particular methods.

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