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Geochemical and magnetic prospection of a Neolithic site: case study from Dzielnica (Poland)

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An interdisciplinary non-invasive survey project including aerial photography and geophysical, geochemical and surface prospection has been conducted in Dzielnica (Opole province) since 2008. Rescue excavations, which began in 2004, are continuing on the site.

The site is a promontory stretching into the wide Oder river valley. Neolithic, Bronze Age and Iron Age population groups repeatedly occupied the landform. Diverse domestic features, mostly dug-in pits, aboveground houses and graves, are related to these settlement episodes, but the most interesting feature associated with human occupation of the late phase of Lengyel culture is a system of ditches forming an enclosure.

The gradiometry survey was conducted using a Bartington Grad601-2 instrument and covered an area of 6.14 ha. The prospection recorded a great number of anomalies resulting from varied and chronologically diverse human action (Fig. 1), occurring throughout the studied area.

Analysis of some magnetic anomalies led to an interpretation of their function, cultural attribution and chronology. Linear anomalies indicating the presence of ditches are particularly characteristic. As the excavations have shown, these features were not ditches *sensu stricto*, but a system of elongated pits, which had been dug successively one into the other. Two parallel ditches aligned SE–NW were traced and a third ditch was found to connecting them in the middle part. The current state of research does

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Fig. 1. Results of the magnetic survey at Dzielnica, Opole (Poland)

not allow for a full reconstruction of the enclosure (especially in the southern and northern directions) or an estimate of its surface area (surely larger than 3 ha). It cannot be ruled out that the system of ditches was more complicated and that a larger number of anomalies may be interpreted as relics of other ditches.

Elongated anomalies or groups of anomalies concentrated in the southeastern part of the area are equally characteristic; they form rows, dozens of meters long and oriented SE–NW separated by empty spaces between them. Their arrangement seems to suggest that they are the remains of households, typical of the Linear Pottery culture communities; they comprise so-called clay pits located along the walls of post-built longhouses. The remains of post-built structures were recorded sporadically as poorly visible rows of triple anomalies. The neighbouring households formed several rows of buildings laid out regularly along a SE–NW line. Such an arrangement of buildings is also characteristic of Linear Pottery culture settlements. The rest of the anomalies are difficult to interpret unequivocally and represent the relics of settlement features related to all phases of site occupation.

Large-scale geochemical analyses were also conducted with the objective of determining the phosphate content in samples from a series of drill-cores and bulk samples collected during the excavations. In total, 900 drillings were made during the project and 3500 samples were

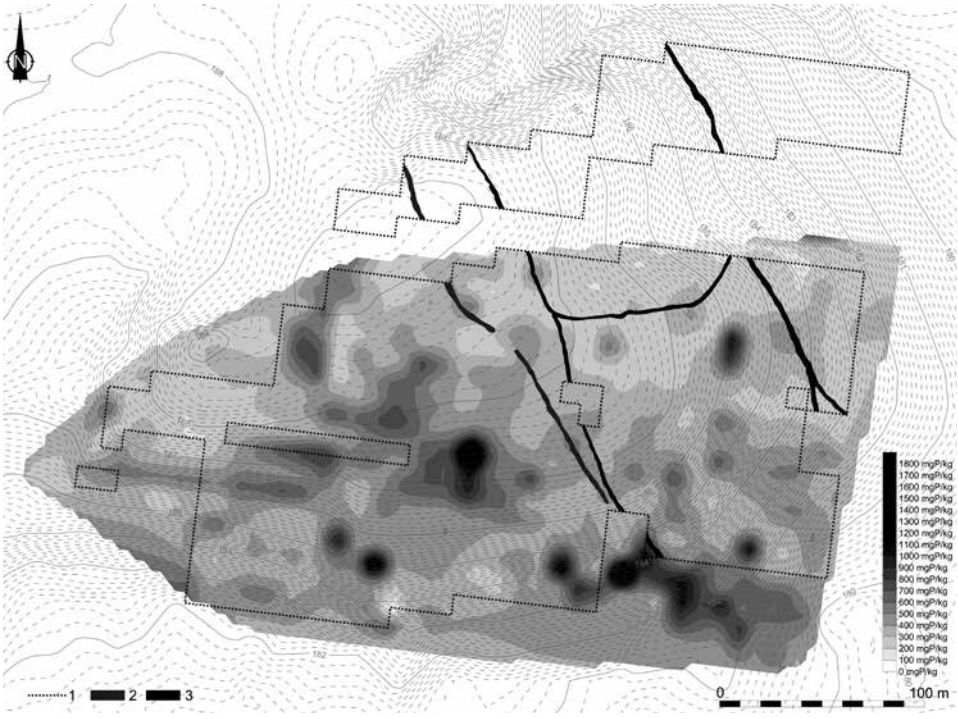

Fig. 2. Map of phosphate content in soil samples (depth 0.4–0.6 m) from Dzielnica: 1 – extent of the magnetic survey, 2 – probable ditch, 3 – ditch

collected and analysed. The studies were carried out following laboratory procedures developed at the Wrocław University of Environmental and Life Sciences (K. Gediga, U. Piszcz). The project took the opportunity to validate some of the methods that allow for a fast analysis of phosphate content in soils with the use of commonly available, portable analytical devices (e.g., Parnell *et al.* 2002; Persson 2005; Lindholm 2006; Rypkemaa *et al.* 2007); these methods included a set of Merck strip tests, a set of Hach phosphate tests (Phosphate Orto Test Kit) and a Merck reflectometer (Reflectometer Rqflex). In all cases, limited applicability of these methods was demonstrated for phosphate determinations on archaeological sites.

Most samples for phosphate content analysis were collected from a regular grid of drillings positioned every 10 m. Apart from these, also three test areas were marked out, where the drillings were made within a 2 m square grid. Soil samples from all of the drillings were taken at three depths: 0.4–0.6 m, 0.6–0.8 m and 0.8–1.0 m. Additionally, samples for analysis were collected, from different levels of the explored archaeological features within a 1 m square grid.

The generally similar character of the results of phosphate analysis obtained from the 10 m square grid and recorded at the three sampling levels bears attention: zones of low and high phosphate content were found in the same parts of the site (Fig. 2). Potential differences are of a local character and arise from the specificity of traces of human activity from the various levels of

the site and inside the settlement features. Of major importance is the lack of correlation between the location of high phosphate content zones and the present-day field boundaries, excluding the impact of contemporary factors on the observed variation in geochemical properties.

A comparison of the distribution of phosphate content in the soil and the results of the magnetic surveys indicate that the space between the ditches of the Lengyel culture enclosure is characterized by relatively low phosphate content values. Elevated levels of phosphate content recorded in the southern part of the enclosure can be attributed to the presence of chronologically older households of the Linear Pottery culture in that area of the site. The amount of phosphate is significantly higher in zones located outside the ditches, mostly towards the west and southwest. This may suggest that the area surrounded by the ditches was not used intensively for economic activities. It can also be assumed that animal access to this area was restricted and their permanent presence (stabling) within the enclosure may be ruled out in all probability. The higher phosphate content outside the ditches may point to a conclusion that this zone was used more intensively for agricultural activities, most likely as a pasture, stabling ground, manured fields etc.

The results of an analysis of samples collected in a 2 m square grid within the test areas generally correspond with those obtained from the 10 m square grid. A denser arrangement of drillings allowed for a better mapping of within the test areas spatial distribution. In some cases, there was an evident coincidence between elevated phosphorus content and the occurrence of single magnetic anomalies, which clearly represented archaeological features. Processes responsible for the formation of the infill of dug-in features (e.g., ditches) are the reason, among other factors, behind the variability of phosphate content in the different layers.

Excavation trenches positioned within the above mentioned test areas allowed to verify the outcome of the geomagnetic and phosphate content prospection. In both cases, results obtained by non-destructive methods were confirmed. This repeatability iproves the capabilities and validity of the applied methodology.

The research conducted at Dzielnica not only contributed to the development of non-invasive prospection methodology, but also led to the formulation of procedures regarding the preparation and analysis of phosphate-content samples from archaeological sites. It also emphasized the significant cognitive value of an integrated research approach involving non-destructive methods.

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