

LOST AND FOUND: THE VALLUM IN LACU AT OSTROWITE (NORTHERN POLAND). A MULTIDISCIPLINARY RESEARCH CASE STUDY

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Abstract

The *vallum in lacu* (rampart by the lake) mentioned in 15th-century written sources as part of the Medieval landscape of Ostrowite (East Pomerania) has been researched by archaeologists and antiquaries since the 19th century. A wide range of non-invasive archaeological prospection methods were applied at Ostrowite in 2010-2015, including magnetic gradiometry, earth resistance, aerial photography, intensive field-walking, geochemical (phosphate) prospection, and the analysis of Airborne Laser Scanning. They were supplemented and verified by small-scale excavation work. This vast set of prospection methods was integrated into a Geographical Information System (GIS), and combined with an analysis of written sources, and allowed for the identification of a previously unknown ring-fort, which for the last 15 years has gone unnoticed by researchers conducting annual excavations in its vicinity. Its discovery and identification were only possible due to the integration of results from various methods, particularly non-invasive ones.

Key words: magnetometry, surface survey, phosphate prospection, electrical resistivity, aerial photography, Middle Ages.

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Introduction

The Ostrowite settlement complex is located on the shore of Lake Ostrowite (also known as Waldsee), approximately 1.5 kilometres northwest of the contemporary village (most likely founded in the 14th century AD). It is situated in East Pomerania, in the northern part of the Kraina Lakeland (Pojezierze Krajeńskie), close to the edge of the Charzykowy Plain (Równina Charzykowska) and the Tuchola Forest Plain (Równina Borów Tucholskich), all in the recently glaciated area of the Pomeranian Lakeland (Kondracki 2002). The region is south of the Pomeranian Lakeland Hump (acc. to Sylwestrzak 1978), which is defined as a limit of the Pomeranian Phase of Weichselian Glaciation (Marks 2010; 2011). The 'Kraina moraine hillocks' (*krajeńskie moreny czołowe*) are in the immediate vicinity of the research area (Kozarski 1995; Kozarski, Nowaczyk 1999).

The main part of the micro-region is situated on a moraine plateau, between 140 and 142.5 metres above sea level. The area is formed by glacial till often covered with glacial gravel and sand with loamy sand. Studencki (2008) distinguished there two levels of glacial till from the Weichselian Glaciation. Upper glacial till (often sandy) forms the surface of the main part of the area. The height differences at the settlement complex area do not exceed two metres, with slopes of three degrees. The area is adjacent to the eastern shore of

Lake Ostrowite. The average water level in the lake is 139 metres a.s.l. The lowest relative heights in the immediate vicinity of the settlement complex are within numerous kettle holes in places occupied by biogenic plains (lakes, swamps, mires and bogs in the past). The micro-region is characterised by a high level of geodiversity, and offers an assortment of natural resources. The complex surface geology resulted in inconvenience in conducting some of the non-invasive investigations.

The village of Ostrowite appears in written sources in 1338 AD, as a result of its location in 'German Law' (Panske 1911). In that year, Dietrich von Lichtenhain, the commander of the Teutonic Order from Tuchola (Tuchel), sold the land at Ostrowite to Niclaus Sulesdorf. Later 15th-century sources suggest a distinctly longer history of the village. A document from the year 1485 mentions a field where the remnants of an old village called Dorfstadt, situated on the east shore of Lake Ostrowite, might be found. There is also a note about a *vallum in lacu*, a rampart by the lake, which the local Respublika (village commune) may 'repair for defensive purposes if they need to' (Lustratio 1908, 213). Andrzej Janowski (1999) hypothesised that this rampart should be identified with a stronghold which was thought to exist on an island in Lake Ostrowite, but admitted that historical sources are not entirely clear on the subject. The supposed island stronghold was mentioned by Władysław Łęga (1930) and Gerard

Wilke (1969). Excavations on the island in 1993 and 1995 did not, however, produce data which would sustain this hypothesis. An analysis of airborne laser scanning derivatives of the area also does not reveal even slight traces of such a feature.

The area around Lake Ostrowite has been a place of archaeological interest since the first half of the 19th century; however, professional archaeological research on a regular basis started here in 1993, and has continued intermittently to the present time (2015). Professional studies concentrated on the area of the Medieval settlement site on the island in Lake Ostrowite, and on remnants of Medieval wooden bridges. Research was carried out in 1993–1994 as part of an expedition by the Archaeology Department of the University of Łódź (Trzcinski 2005), in 1995–1996 by a team from the Institute of Archaeology of Nicolaus Copernicus University in Toruń (Janowski 2002a, 2002b), and since 2000 by an expedition by the Institute of Archaeology of the University of Łódź, initially under the direction of Krzysztof Walenta (2006–2007), and since 2008 by J. Sikora (Sikora, Trzciński 2011). Simultaneously, underwater excavations which aimed to localise and document wooden bridges were surveyed by divers from Nicolaus Copernicus University in Toruń (Chudziak et al. 2009).

The following settlement horizons were noted during subsequent research projects:

1. traces of neolithic settlement of the Linear Pottery culture (about 5000 BC);
2. settlement features and a cremation burial place of the Pomeranian culture from the Iron Age, approximately 500 to 100 BC;
3. settlement and production features of the Wielbark culture (100–300 AD) (Kittel, Sikora 2016), and a single ‘princely’ burial from the second century AD (Walenta 2006–2007);
4. remnants of a settlement, bridge and inhumation burial site from the Medieval period (Sikora, Trzciński 2011; Drozd-Lipińska et al. 2013; Sikora, Wroniecki 2014; Sikora et al. 2015a), 1050–1300 AD.

Both Roman Period (Wielbark culture) and Medieval phase are confirmed by series of radiocarbon scintillation and AMS dates of organic matter and human bones and TL dates of pottery and burned clay.

Several archaeological sites were distinguished in the micro-region (Fig. 1):

1. site no 1 (AZP, Polish Archaeological Record, number for heritage purposes: 26-34/2): Medieval island settlement on the Lake Ostrowite island;

2. site no 2 (AZP 26-34/3): prehistoric and Medieval settlement, ‘princely’ burial, Medieval cemetery on the eastern shore of the lake;

3. site no 3 (AZP 26-34/6): remnants of bridge constructions dated to the Middle Ages located on the bottom of the lake;

4. sites nos 5 and 6: initially recognised traces of settlement from Prehistoric to modern times, on the southern shore of the lake.

Over so many years of excavations, up to 2010, no traces of any Medieval stronghold were detected; however, only a small percentage of the entire archaeological complex (estimated to expand to almost 30 hectares) was subject to excavation. Taking into account both the vastness of the archaeological resources in the area and the various threats to their state of preservation, resulting mainly from intensive tillage erosion (due to EU subsidies for the purchase of new agrotechnical machinery, it now reaches a previously unthinkable ploughing depth of 0.5 m), it was necessary to undertake an attempt at large-scale archaeological field research. It was decided to fulfil this aim with the use of a wide range of non-invasive techniques, which included aerial prospection and documentation, geochemical (phosphorus) sampling, and multi-method geophysical prospection. Since 2008, GIS software has been applied to document excavations and ongoing parallel archival inquiries (including written and historical cartographical sources); therefore, it was a natural decision to supplement this database with non-invasive surveys. The result is a system that integrates a wide range of research, and allows various analyses in a unified digital environment (Sikora, Wroniecki 2011, 2014).

Methods

1. Aerial prospection: orthophotomaps from the National Archive of Geodesy and Cartography and free Internet resources were used (geoportal.gov.pl, Google Earth/Maps, Bing Maps). Oblique aerial images were carried out from a high-wing, two-seater aircraft on various dates. In 2006 and 2012, four such sessions were carried out by W. Stępień. Additionally, since 2012, several sessions have taken place with the use of remote-control drones (UAV). Selected images were geo-referenced in QGIS software and/or mosaicked in Agisoft Photoscan photogrammetry software. Orthophotomaps from WMS of national geoportal (geoportal.gov.pl) service were used as backgrounds.

2. Geophysical prospection: two methods were applied, magnetic gradiometry and earth resistance (As-

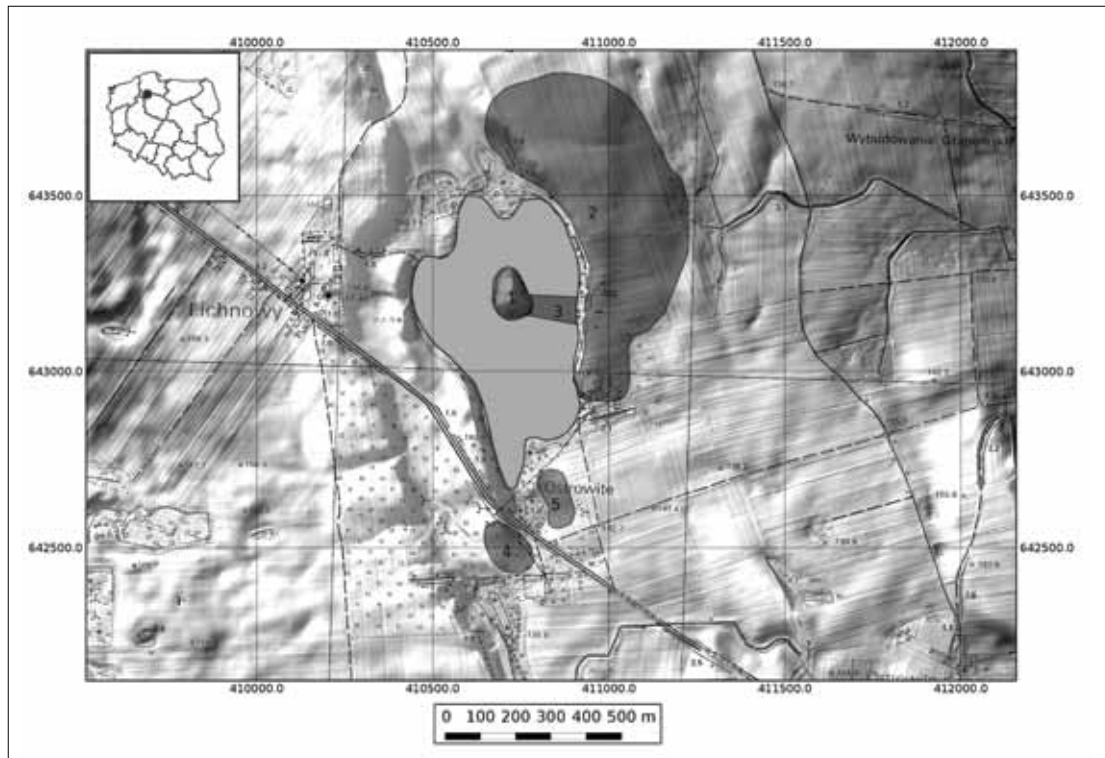


Fig. 1. Archaeological sites in the region of Lake Ostrowite (background: LiDAR derived NTM, CODGiK, ed. by Sikora).

pinall et al. 2008; Clark 2000; Gaffney et al. 2000; Kvamme 2006, Scollar et al. 1990). The non-invasive research programme adhered to tried and tested procedures (Gaffney, Gater 2003, 88ff.), which suggest initiating geophysical studies with the fastest and most cost-effective methods, and with the greatest cognitive potential, such as the magnetic method. Further studies were to be used in a narrower range, applying methods which might be more time-consuming (hence costly), such as GPR or earth resistance. This type of approach would allow the fullest possible understanding of underground structures with the best possible time/cost result ratio.

During the first test survey in 2010, only a small, 1.6-hectare magnetic survey was carried out (Table 1). This survey continued in 2012, but with a higher sampling rate (0.5 m × 0.25 m) to ensure greater data quality. An earth resistance survey was employed as a complementary method. Both surveys took place at site no 2 (Tables 1, 2).

3. Field-walking survey: took place in 2012, and encompassed an area of nine hectares on the east shore of Lake Ostrowite. Artefacts were collected within 40-metre grids (Drewett 2001). Additional data was collected in the Archaeological Record of Poland (AZP) methodology (Rączkowski 2011) on an area surrounding Lake Ostrowite.

Table 1. Magnetic gradiometry survey parameters

Study area	8 ha (2012 r.) & 1ha (2010 r.)
Grid size	40 m x 40 m
Instrument	Bartington Grad601-Dual
Sensors	2
Type of instrument	Fluxgate gradiometer
Data collection	Zig-zag
Sampling	0,5 m x 0,25 m (2012 r.) & 1m x 0.5m (2010 r.)
Terrain availability	high, plough fields
Date	September 2010 & September 2012

Table 2. Earth resistance survey parameters

Study area	1 ha
Grid Size	40 m x 40 m
Max. depth	AM=0,75m
Instrument	Elmes ADA-05
Electrode setup	<i>Twin probe</i>
Sampling	1 m x0,5 m
Terrain availability	high, plough fields
Date	September 2012

4. Geochemical prospection: took place in 2012, and encompassed an area of six hectares at site no 2, partly covering the area of other surveys (field-walking, excavations, geophysical and aerial photographs). A simplified method for the field determination of phosphorus content in the soil was used, developed on the basis of R. Eidt's (1973) method, based on the molybdate method of Arrhenius (1950), and modified. The modification of the field determination of phosphorus in the soil method was elaborated by W. Tołoczko (Department of Physical Geography, University of Łódź) and P. Kittel (see: Kittel, Sygulski 2010; Sikora et al. 2015a, 2015b). Similar prospection is recommended by Ayala et al. (2007). It was modified by applying a template by means of which soil samples were prepared with the same volume. An evaluation of the content of phosphorus in the soil was performed using a contracted scale in a range from zero to five degrees, where zero means no or a very low level, and five an extremely high content of phosphorus in the soil. Samples were collected in the field within a grid of ten by 20 metres, at a depth of about 90–100 cm b.g.l., with the use of a hand auger, usually from deposits at the base of the site. Geochemical analysis was performed in total for 271 samples. The documentation of the surface geology of the site area was gathered also during the collecting of samples.

5. The verification of non-invasive surveys through archaeological excavations has been conducted since 2010 by J. Sikora, as part of a University of Łódź Archaeological Field Expedition. Digital methods of documentation, photogrammetry, GPS RTK and Total Station measurements, are an integral part of these actions, and allow for the precise localisation of the verified structures, and their subsequent comparison with various anomalies and crop marks which revealed them.

6. GIS integration: the integration of all available data within a single system turned out to be the key problem of the research at Ostrowite. The wide range of prospection techniques applied required

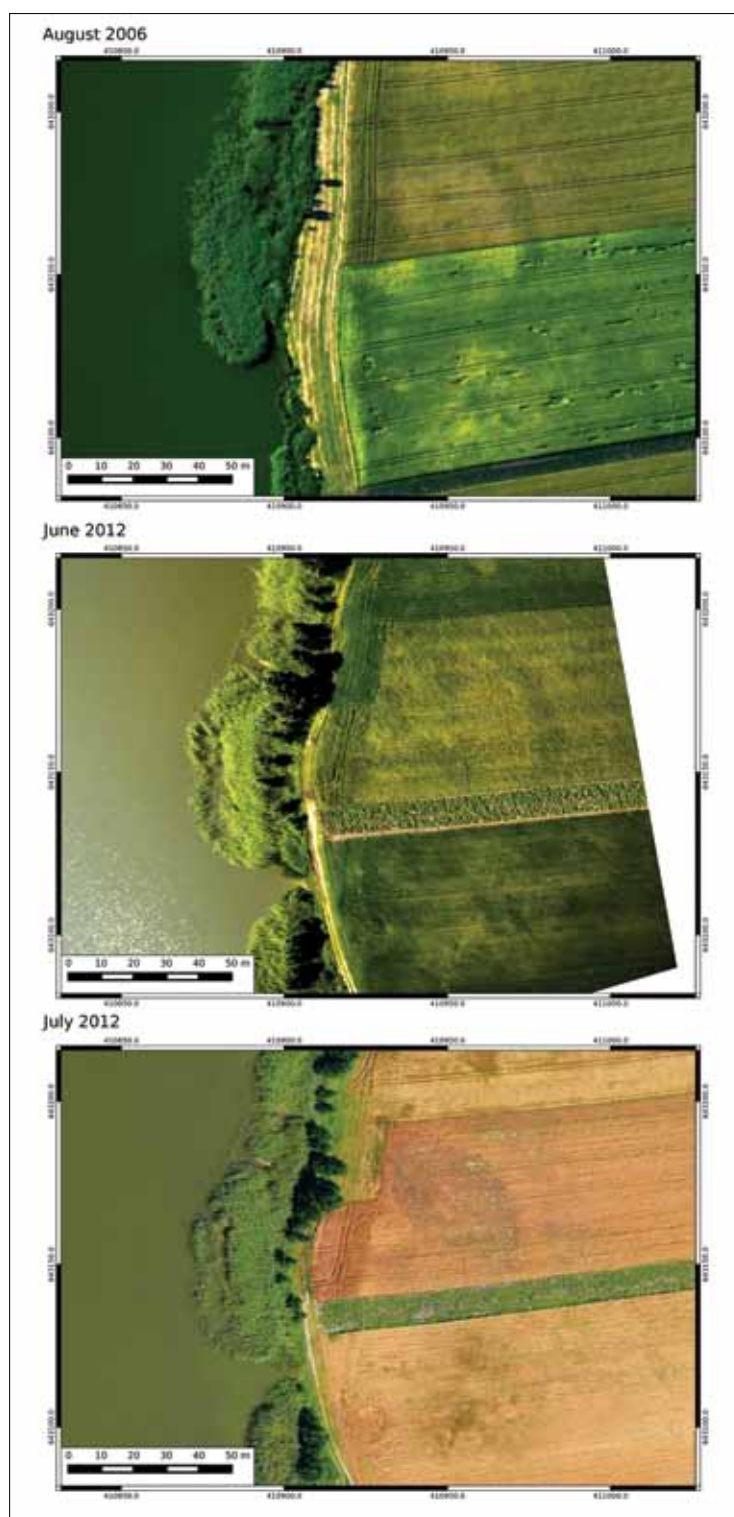


Fig. 2. Aerial photographs (ed. by Sikora) of Ostrowite ovaloid structure (supposed ring-fort).



Fig. 3. Aerial photograph from a drone (photograph by Wroniecki) of Ostrowite ovaloid structure (supposed ring-fort).

the possibility for the easy and clear comparison of various results. Using GIS techniques not only enabled the management of the data collected, but also its comprehensive analysis and presentation. The structure of the GIS database allowed for the integration of the results of various analyses.

The system created for the Ostrowite settlement complex includes various raster, vector and WMS layers, including archival and contemporary maps (both topographical and orthophotomaps), as well as calibrated oblique aerial images, digital excavation plans and cross-sections, contour maps (from 1996 and 2012), digital terrain models from airborne laser scanning, and finally raster geophysical maps.

In addition, the system includes vector layers representing an interpretation of the results of non-invasive prospection. These layers were linked to database tables describing attributes, quantitative and qualitative characteristics of the individual elements. They allowed for the creation of a series of cartograms and thematic maps presenting the results of the work carried out in the various chronological horizons.

It should be noted that the GIS integration was built entirely based on Open Source software. This is of particular importance for archaeologists, who often face the problem of financing their research. In addition, access to the source code allows the community centred around Open Source GIS projects direct insight into the applied algorithms of individual analytical tools, which provides for the scientific control of test procedures (Ducke 2012). At Ostrowite, Qgis was the main software package, supplemented by gvSIG and SAGA GIS.

Results

In 2010, oblique aerial images taken in 2006 were georeferenced and implemented in the recently formed GIS for Ostrowite. This action allowed for the precise localisation of an ovaloid feature registered on the eastern shore of Lake Ostrowite (site no 2). It was situated in an area of previously discovered relics of two wooden bridges; the older one dendrochronologically dated to after 1159/1160 AD, and the younger to after 1299 AD (Chudziak et al. 2009). Subsequent aerial images taken in 2012, 2015 and 2017 as well as an

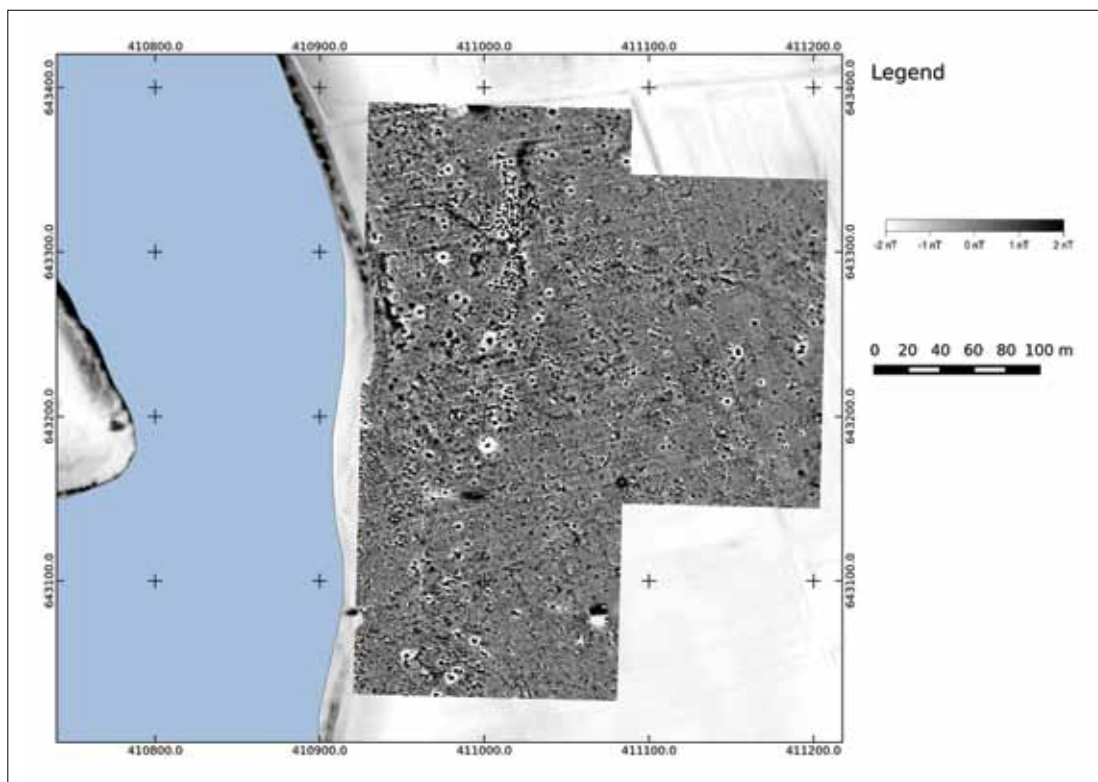


Fig. 4. Ostrowite. A visualisation of the distribution of the vertical gradient of the magnetic field (background: LiDAR derived NTM, CODGiK, ed. by Sikora, Wroniecki).

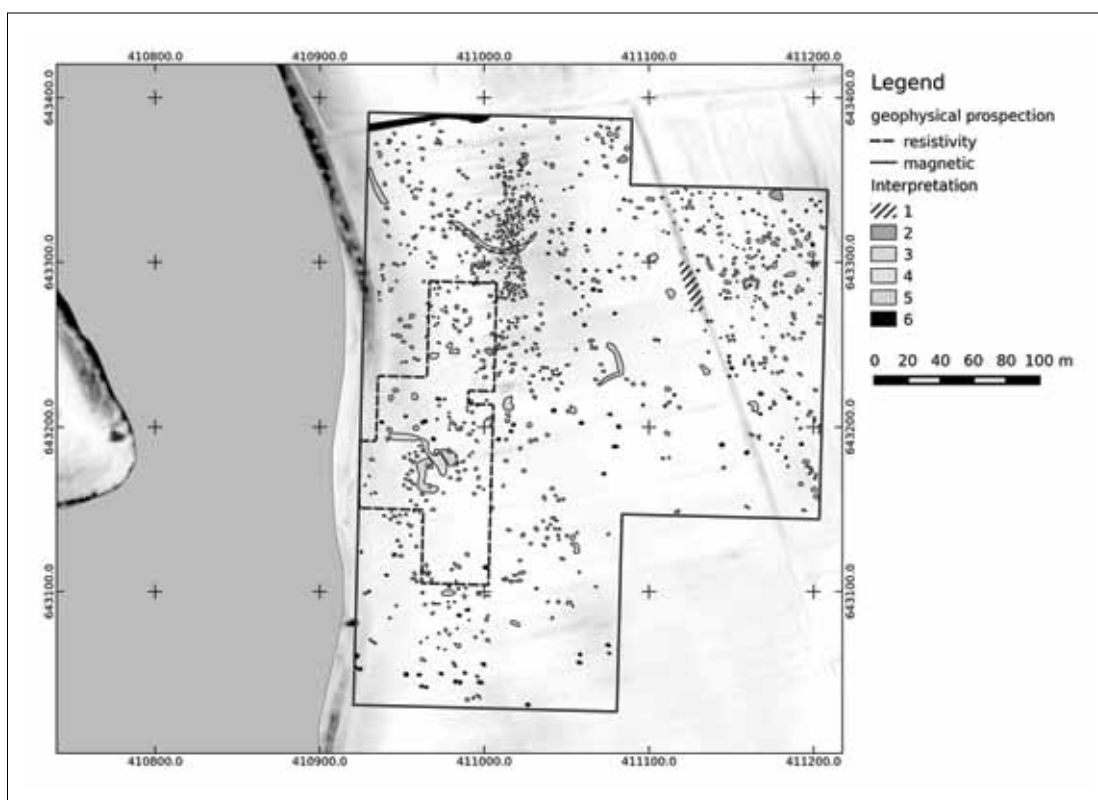


Fig. 5. Ostrowite. An interpretation of archaeological geophysical anomalies (ed. by Wroniecki): 1 modern intercalations; 2 possible production features; 3 background soil variations; 4 cut features; 5 traces of excavations; 6 magnetic items.

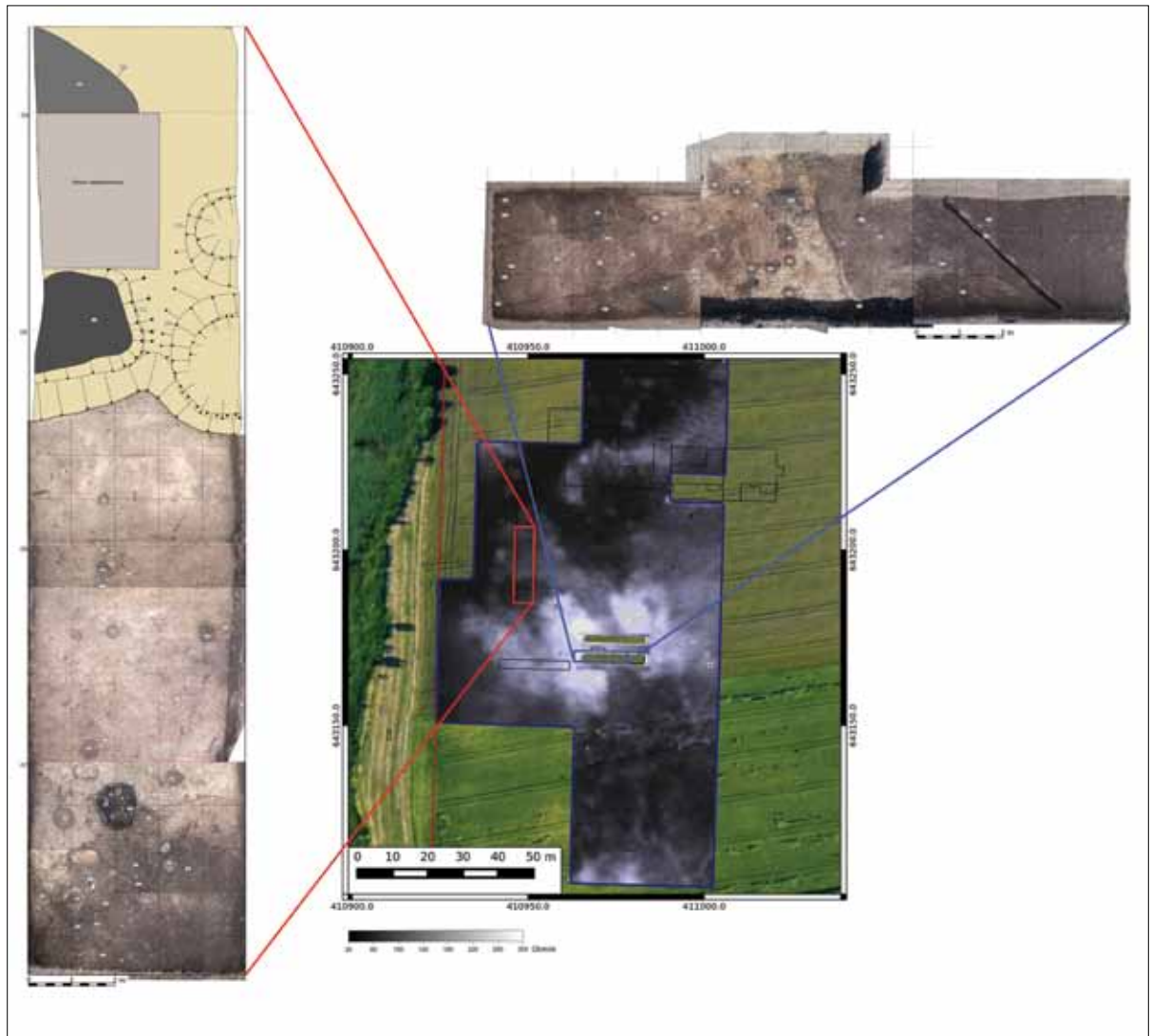


Fig. 6. Ostrowite ovaloid structure (supposed ring-fort) earth resistance measurements, and plans of trenches with the remains of a ditch (ed. by Sikora).

analysis of archival photographs from the 1960s to the 1990s, confirmed the presence of this archaeological feature (Figs. 2, 3). The presence of an ovaloid structure was also partially confirmed by a geophysical survey conducted in 2010. It was captured magnetically only in the northern part. It generated a very weak anomaly with an amplitude of about $\pm 1\text{nT}$ in relation to the natural magnetic field, which is on the border of the actual sensitivity of the instrument used. It is very likely that without prior knowledge of the existence of such a feature from aerial images, it would be overlooked during geophysical interpretation. In 2012, the survey was repeated and expanded, using a higher sampling resolution; however, the results were still not satisfactory (Fig. 4). Earth resistance, as the second method of geophysical prospection, was also applied in 2012 (Fig. 5). Further information about the stratigraphy of the ovaloid feature was obtained. A low resistance anomaly corresponding in shape and size to the

crop mark was registered. A second, similar anomaly, running parallel, was faintly visible to the west.

Excavations were carried out in 2010 in order to verify the ovaloid feature. A five-by-35-metre trench was staked out in the northern part of the structure (Fig. 6). The results were inconclusive, but revealed a shallow feature with a width of 14 metres and a depth of 0.7 metres. This feature was severely transformed in its lower part by a series of pits, which were interpreted as relics of clay pits. Their fill contained Medieval potsherds chronologically set between the second half of the eleventh century and the end of the twelfth century AD. Follow-up excavations in 2012 encompassed a second test trench of about three by 20 metres in the ovaloid feature's eastern section. Once more, the presence of a sunken, linear feature was documented, with a width of eight to nine metres. In both test trenches, a strip of about four metres consisting of humic sands with irregularly spaced post holes was registered. Fur-

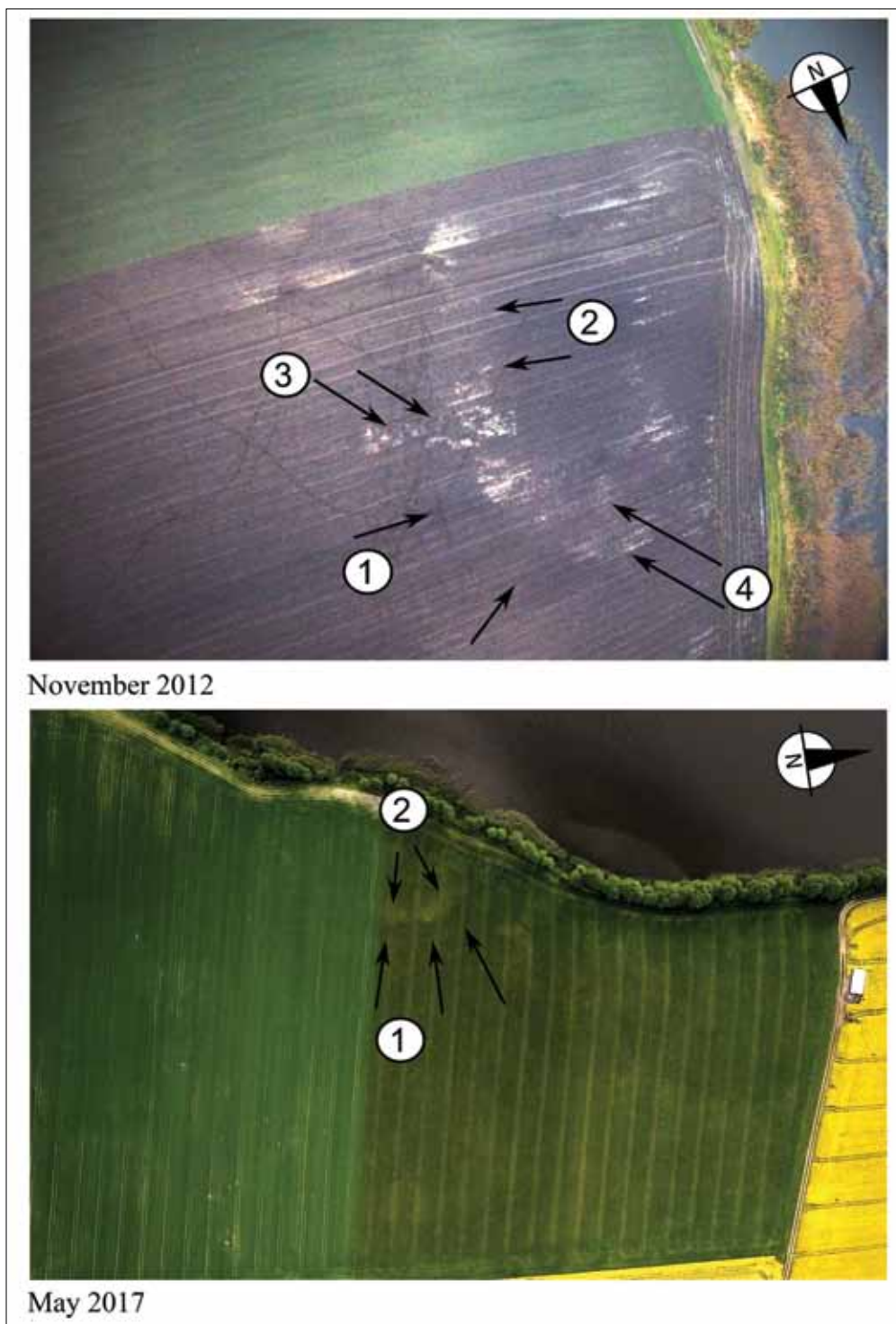


Fig. 7. Ostrowite. Aerial photographs of ovaloid structure (supposed ring-fort) (photos by Wroniecki). 1. dry moat; 2. sandy area (supposed foundation of the rampart); 3. trench from 2012; 4. trench from 2010.

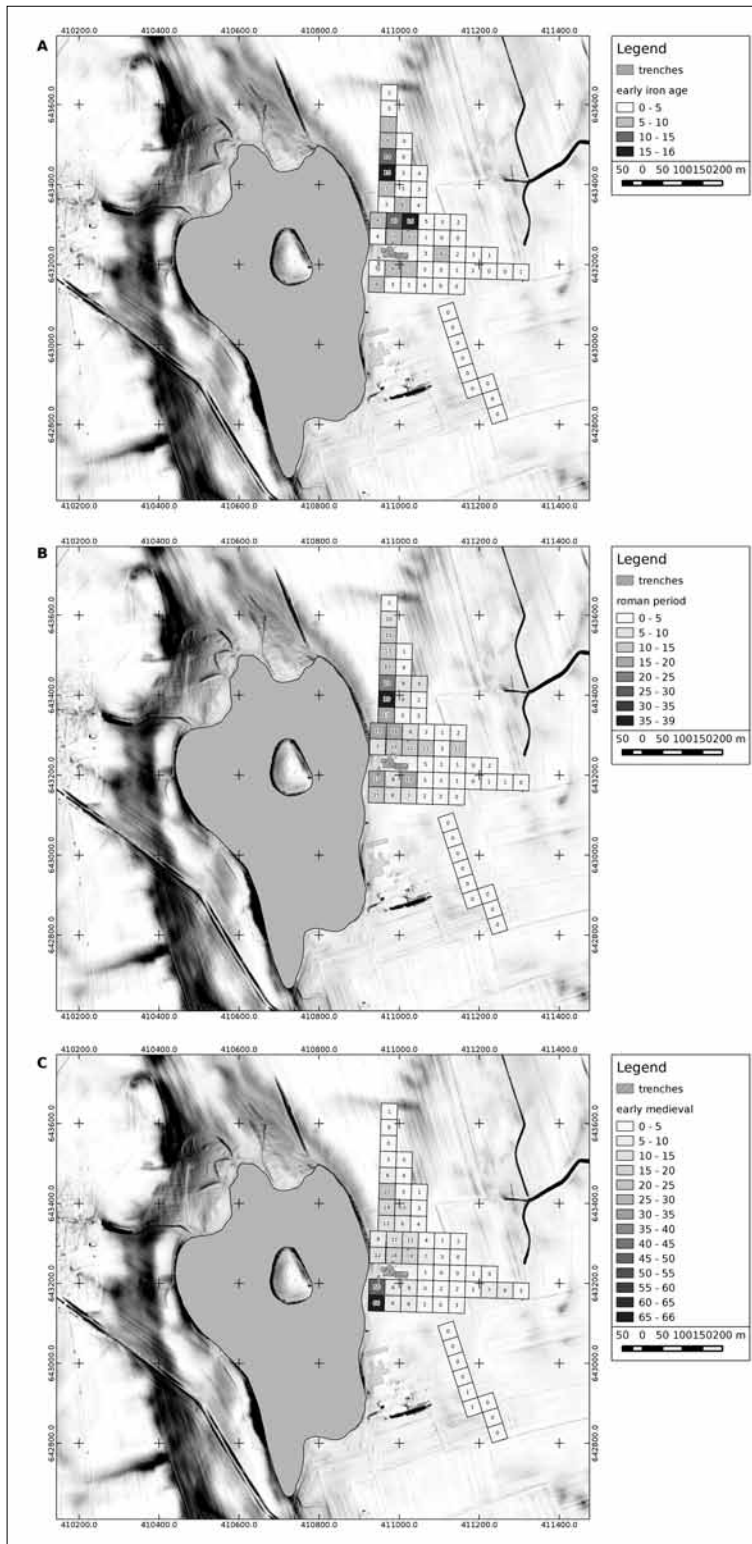


Fig. 8. Ostrowite site 2. Surface survey results (ed. by Sikora):
A 500–100 BC; B 10–300 AD; C 1050–1300 AD.

ther south in trench from 2010 and west in trench from 2012, cultural layers of negligible thickness, and with settlement features including a hearth and surrounding post holes, were recorded (Sikora, Wroniecki 2011; Drozd-Lipińska et al. 2013).

Aerial images taken in November 2012 produced further information about the ovaloid structure. For the first time, aerial images were taken at a time of year which allowed for the registration of soil marks. Although poorly visible, a darker ovaloid zone corresponding to previously registered crop marks and running adjacent to it on the inner zone, and a layer consisting of brighter sandy soil, were visible. Furthermore, the test trench from 2012 was clearly visible. Based on the results of various surveys, this ovaloid structure may cautiously be interpreted as the previously described strip of sandy buried soil adjacent to the ditch on the inner side. A similar situation was revealed in pictures with crop marks taken in May 2017. There was a light strip of vegetation growing on sands adjacent to a wider and darker strip of vegetation growing on the soil from the linear sunken feature (Fig 7).

In 2014, additional excavations were conducted. A test trench of 2.5 by 20 metres cut a second, inner anomaly of lower resistance recognised during a geophysical survey parallel to the one previously described. During excavations, a sunken feature with clearly visible relics of a fire-place and several post-holes were revealed. Twelfth-century potsherds were obtained, helping to establish the chronology of this structure.

Further information was provided by the phosphorus and surface surveys (Figs. 8, 9). Direct evidence was obtained through the correlation of the higher content of phosphorus in the soil (values from 3 to 5 degrees), with an intense concentration of potsherds and a higher turnout of magnetic anomalies. On the periphery of these

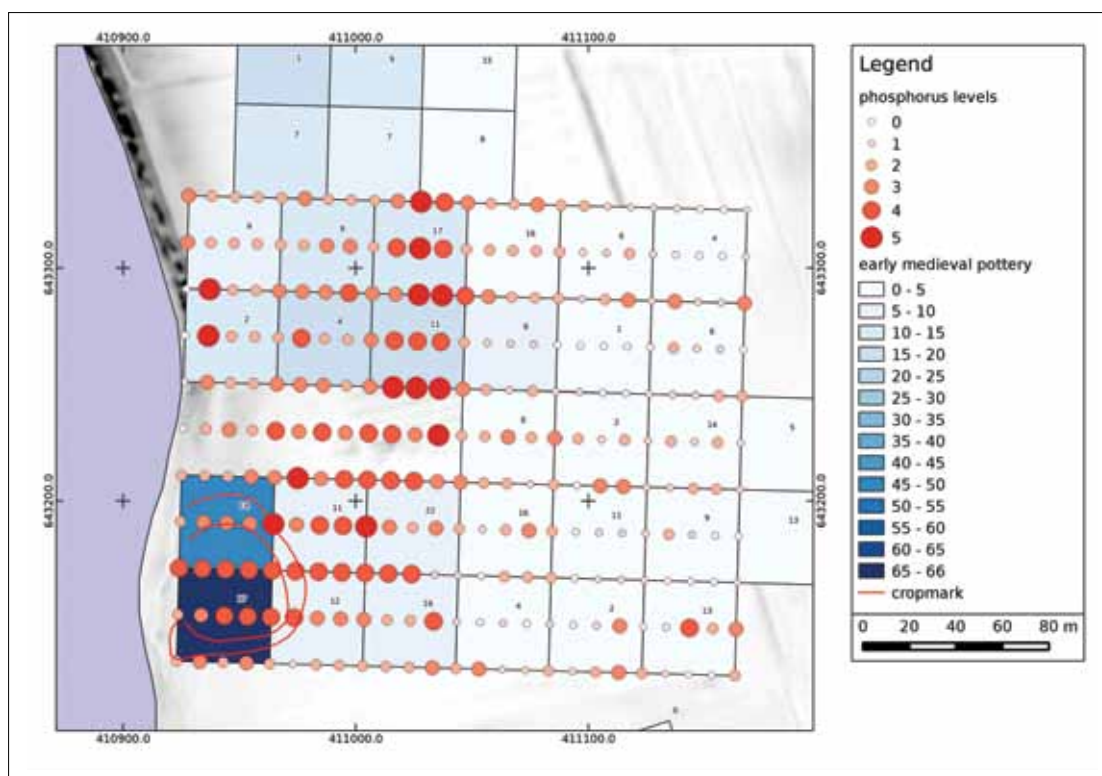


Fig. 9. Ostrowite site 2: the results of the phosphorus prospection and the frequency of surface material from the Early Middle Ages (circa 1050 to circa 1300 AD), against the ovaloid structure shape based on rectified aerial photographs (drawn by Sikora).

areas, the phosphorus saturation in the soil was decisively lower, usually at the level of 2 degrees. In the area of the ovaloid structure, high values of phosphorus saturation, at a level of 4 degrees, were recorded. The dispersion of archaeological surface material from the Middle Ages was the highest across the area overlapped by the discussed ovaloid structure. More importantly, the amount of potsherds chronologically associated with the Iron Age (Pomeranian and Wielbark cultures) was relatively sparse in this area: fragments of pottery of these chronological horizons in their most intense concentrations were recorded mainly in the highest areas of hills surrounding the lake shore.

Discussion

Medieval (mostly twelfth to the first half of the thirteenth century) potsherd finds are prevalent in the ovaloid feature's fill, as well as in other, smaller features located within the area it encloses. The relatively high amounts of finds from this period observed during field-walking surveys, as well as the evocative spatial arrangement, indicate a possible association of the ovaloid feature with the remnants of a wooden bridge found in the lake, linking the mainland with the island. The potsherds dated to the same period were excavated in test trenches in 2010, 2012 and 2014. This would al-

low us to propose a 12th or 13th-century AD chronology of the feature.

The whole structure was contained within a wide (up to 14 metres) and relatively shallow (to 0.7 metres) dry moat, with a strip of sand adjacent to the inner side. The sandy area cut only by several post-holes should probably be understood as the foundation of an unpreserved rampart. The post-holes could have been connected with the inner timber construction of the rampart. Its shape and details of its construction remain unknown, since the whole supposed embankment was destroyed in the Late Medieval and Modern period.

The results of integrated prospection methods should be compared, and then combined with an analysis of previously mentioned written sources (Fig. 10). Several landscape elements are mentioned in them:

1. *Dorfstadt*. The remains of the previous location of the village of Ostrowite, on the eastern shore of the Lake. It should be situated in the place of site 2, with a number of elevated features and a significant amount of potsherds revealed during field-walking.
2. *Vallum in lacu*. A rampart which the local community could repair, according to a 15th-century document. Its remains were not located on the island, but we have enough arguments to identify it with the ovaloid feature on the eastern shore described above.

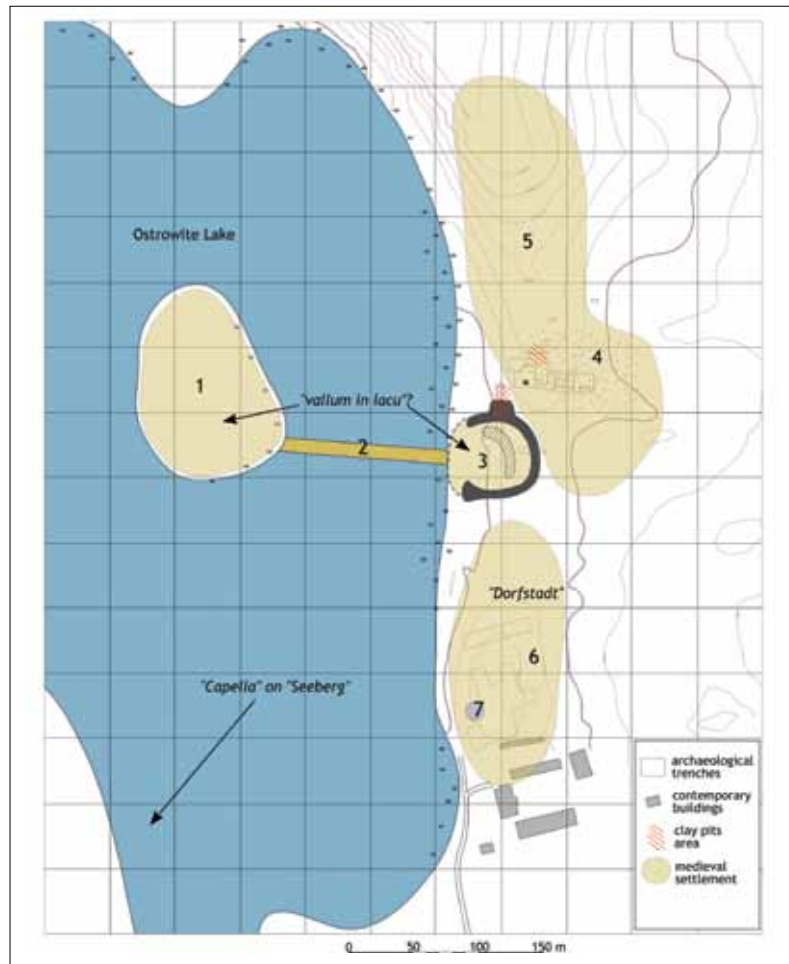


Fig. 10. An attempt to reconstruct the Medieval settlement complex at Ostrowite: 1 the settlement on the island (site 1); 2 the wooden bridge (site 3); 3 the area of the supposed ring-fort (the course of the ditch in dark grey, the inner zone of internal buildings in grey hatching) (site 2); 4 inhumation cemetery (site 2); 5, 6 open settlements (site 2); 7 the 'princely grave' from the Roman period (it is not clear whether it was still visible on the surface during the Middle Ages) (site 2). Local names from the source document of 1485 (drawn by Sikora).

3. *Capella*. The older church, situated, according to sources, on the southern shore of the lake, still remains uncovered. The present church in the village of Ostrowite was built at the beginning of the 15th century. On the southern shore of the lake, two archaeological sites with Medieval potsherds were identified in the course of field-walking in 1996, and then in 2012. They are described as sites nos 5 and 6, and could potentially be connected with a previous church.

Conclusions

The various non-invasive prospection techniques used between 2010 and 2017 and verification through excavations in the 2010, 2012 and 2014 allowed for the identification of several elements of the archaeological landscape, completely levelled and devoid of any terrain, forming the remnants of a medieval stronghold. The ovaloid shallow sunken feature should be understood as a dry moat. The strip of sand behind the fea-

ture, together with post-holes should be interpreted as a trace of a rampart. All of those features constituted a ring-fort completely destroyed by ploughing in the Late Medieval and Modern era. The stronghold was most probably connected with a timber bridge leading to an open (?) settlement on the island. This feature, despite years of intensive archaeological investigations through excavations, has never been noted to exist, and could be detected most of all through the application of multiple and complex non-invasive methods, integrated in a GIS environment, and finally thoroughly compared with written sources. We have to stress that without non-invasive surveys, the proper interpretation of this extremely poorly preserved feature based on data from test trenches would probably be impossible. This conclusion is in direct opposition to the predominant and often indisputable paradigms of archaeological research in Poland, where excavations form the basis of 'real' knowledge about the past.

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PRARASTAS IR SURASTAS: PYLIMAS PRIE OSTROWITE EŽERO (ŠIAURINĖ LENKIJA): TARPDISCIPLININIS ATVEJO TYRIMAS

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Santrauka

Apskritas pylimas ant Ostrowite ežero kranto (*vallum in lacu*) kaip apylinkės kraštovaizdžio akcentas minimas XV a. rašytiniame šaltinyje. Šis pylimas archeologų ir mėgėjų yra tyrinėjamas nuo XIX amžiaus. Daugelis nedestrukcinų metodų buvo taikyta tyrinėjant šį pylimą 2010–2015 metais. Tyrinėjant minimą pylimą, buvo atliekami intensyvūs aplinkos žvalgymai, magnetometriniai, paviršiaus rezonansiniai, geocheminiai (fosfatų) tyrimai, lazerinis skenavimas ir daromos oro fotografijos. Minėti nedestrukciniai metodai buvo papildyti nedidelės apimties archeologiniais tyrimais (1–10 pav.). Gauti rezultatai buvo integruoti į geografinę informacinę (GIS) duomenų sistemą, o tai leido juos sieti su rašytiniais šaltiniais ir kitais duomenimis. Minėtų skirtingų nedestrukcinų tarpdalykinių tyrimų visuma leido šį apskritą pylimą, kuris kurį laiką buvo prarastas, identifikuoti.