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NEIL LINFORD

A review of the English Heritage Geophysical Survey guideline - are they useful for you?

In 1995 the English Heritage for the first time defined the guidelines for geophysical survey in archaeological field evaluation. The original text, fully updated in 2008, is a valuable source of reference both for geophysical practitioners and a wider audience of archaeologists who seek advice for appropriate use of methodology and the ability to contract this work into archaeological projects. The article presents the content of the current English Heritage guidelines and discusses how to apply them with particular emphasis on knowledge concerning the specification of appropriate research models provided by experienced practitioners. Although many legal acts discussed in the guidelines pertain strictly to England, inquiries about geology, types of soil and reaction of various archaeological structures on the specific geophysical techniques prove substantially universal. This paper aims to explore the intrinsic flexibility offered by the guidelines, highlighting some important issues that have arisen from their use within the English planning system over almost 20 years, and determine how, potentially, such a document may form the basis for wider local adoption.

Tomasz Herbich

On problems of standardising commercial archaeo-geophysical prospecting: from measurement to interpretation

Summary

The present text is a shortened version of an hour-long lecture delivered at the 2nd All-Poland Archaeological Geophysics Conference. The full text together will illustrative material is available on SNAP website (http://snap.org.pl/wp-content/uploads/Problematyka_standaryzacji_komercyjnych_badan_archeologi.pdf)

The rapid growth of demand for geophysical prospecting of archaeological sites in Poland over the last five years has resulted in an increased activity of private firms. Since the level of knowledge and information these present varies considerably, it has become vital to set down the standards that the research should meet. Defining standards is also essential in view of the poor familiarity with geophysical surveying that most archaeologists who commission research are guilty of. Having no necessary knowledge archaeologists are unable to correctly estimate either the quality of the commissioned service or to evaluate its costs.

In order to acquaint the reader with the problems of standardising archaeo-geophysical prospecting the paper briefly outlines three stages that can be distinguished in the prospecting process: field measurements, processing, and presentation of results and their interpretation. In view of the author's experience the paper is confined to a discussion of issues connected with research employing magnetic and electrical resistivity methods.

In his discussion of field measurements the author emphasises such factors as the measuring grid density and, in the case of magnetic prospecting, the measuring mode (parallel or zigzag – Fig. 1). These factors mainly make geophysical research so time-consuming and by the same token are responsible for their costs. Selecting a proper measuring grid should follow from a clearly stated research target. The grid density will be different for defining the area of extensive structures (eg a settlement extension, course of wide ditches) and for obtaining a more detailed picture of small-sized objects (eg small pits, postholes, small hearths). The interdependence between the grid density and the structure image is illustrated by instances: for the magnetic method - results obtained at the Neolithic and Early Bronze site in Słonowice in southern Poland (Figs 2-4 and 6-8) and for electrical resistivity method – results from the Greco-Roman town of Pelusium in north-western Sinai in Egypt (Fig. 11). The author also calls attention to determinants that must be taken into account while selecting the measuring mode. The parallel mode, practically abandoned as too time-consuming, can in some cases provide information that would be suppressed in standard processing of data obtained by overwhelmingly used zigzag mode. This is illustrated by the results of explorations in a fortified settlement in Burg Ghana in Germany, where during standard data processing (obtained in the zigzag mode) the image of extensive earthwork structures with minimum values diversification (Fig. 9) disappears. The zigzag mode can be used with no loss to the quality of the result at sites with discernible large difference between magnetic values of structures and the values of their environs, the latter being homogenously low. This is exemplified by the water network from the Greco-Roman period in Philoteris in Faym oasis in Egypt (Fig. 12). The remarks presented in this section of the paper do not refer to mobile multisensor (or multielectrode) measuring systems in which the time factor of the study is of little significance, but relate to equipment manually transported during measuring.

In his discussion of the processing and interpretation of the results the author stresses the necessity of implementing specialist software (eg Geoplot or Archaeosurveyor) which help to eliminate errors resulting from the measuring methodology involved. Lack of access to this type of software leads to publication of maps containing errors caused, for instance, by deploying the zigzag mode, or combining polygons into one map in graphic software (eg Photoshop). Such procedures limit (or reduce to nil) the possibility of a correct interpretation of results. The author decidedly favours presenting results as greytone maps over multicolour maps (as demonstrated by the map of the temple precinct from the Late Period and the Greco-Roman period in Balamun in the Nile Delta, Fig. 17), believing that colour maps (or introducing an additional colour to a greytone map) can only be used in exceptional cases, eg to clearly expose in one map both anomalies of large amplitude caused by pottery kilns and anomalies of small amplitude caused by silt architecture. This is demonstrated by the map of a Greco-Roman pottery production centre in Buto in the Nile Delta (Fig. 16), erected on earlier Late Period constructions. In many cases multicolour maps (typically presenting results in a wide values range) serve to conceal measurement errors (and the inability to remove them). The author postulates supplying reports with greytone maps, with many value ranges from the wide range to the narrow one, as the best way of exhibiting structures with both high and low value amplitude. Such maps (especially those in a narrow value range) allow to easily recognize the level of the researcher's ability to operate the equipment and his digital data processing skills.

In his discussion of the interpretation stage the author underlines the necessity of striking the right balance between a minimalist interpretation (consisting in merely marking anomalous zones on the maps with no attempt at their interpretation) and a maximalist one (an instance of wishful thinking, with postulating the presence of objects without sufficient foundation in results). The first type of reading is safe for the interpreter since the possibility of error here is practically non-existent, while the other can produce disastrous effects once excavation results fail to confirm the suggested interpretation. In such a situation the archaeologist commissioning the study might altogether dispute the sense of carrying out any further geophysical prospecting. The author favours a reconstruction of archaeological structures based on geophysical results and a proposal of a site reconstruction only as far as the obtained results permit. This approach is exemplified by the prospection results from Bawit in central Egypt, which allowed to reconstruct significant fragments of an early Christian monastic complex and to correctly localise structures unearthed over a century ago (Figs 18-19). The author also draws attention to the need of a careful comparison of the geophysical map with landform features, since some anomalies (of a characteristic that can suggest connection with archaeological structures) originate from the surface relief.

The author also emphasises the need to provide maps with the scale of the measured physical value: magnetic field intensity or the resistivity of the ground. Absence of such a scale can thwart contrastive analyses of results, and in extreme cases even make it impossible to obtain information about the methods deployed (when such information is lacking from the map's legend). It was the acceptance of such research documentation not just by local monument conservationists but by academic cognoscenti as well that persuaded the author to broadcast far and wide the recognition of issues connected with prospecting standardization and to suggest concrete guidelines (following those that have been put forward by the English Heritage, for instance).

Summarising, the author proposes complying with the following standards:

1. Measurement density. The magnetic method: the accepted standard will be the distance of 0.5 m between profiles. In particular cases, when we look for extensive structures (ditches etc) or if we have to define the area of the site without being concerned with its detailed layout, the distance between the profiles can be increased to 1 m. The measuring step cannot be less than 0.25 m. Electrical resistivity method: for structures located down to 0.5 m the accepted standard will be the distance of 1 m between profiles, with the measuring step of 0.5 m. For structures located deeper down the measuring step can be lengthened to 1 m, with the between-profile distance of 1 m.
2. Parallel mode or zigzag mode (relevant only for the magnetic method) – depending on the desired image detail level and the equipment used:

– if the contractor deploys fluxgate instruments, the zigzag mode is perfectly appropriate for producing less detailed maps. In order to obtain the most faithful possible image on a dense grid, reflecting the changes in the shallow geology of the subsoil, parallel measurement mode produce better results. The zigzag mode is out of the question if the contractor has no access to software correcting image distortion due to the application of the mode. The zigzag mode does not much lower the result quality for sites with a neutral background and high value amplitude of the sought-for objects, eg ovens. In such cases distortion correction does not diminish the body of information;
– if the contractor uses caesium magnetometers, the zigzag mode produces a smaller number of distortions due to shorter measurement time.

3. Result presentation: the relevant question concerns the software at the disposal of the research contractor. If the practitioner uses a fluxgate instrument and does not employ software of the Geoplot or Archaeosurveyor type (or any other software offering the basic correcting functions of image distortions caused by the measurement mode), we have good reasons to doubt the accuracy of the results' presentation.

   Positive or negative scale: the report should include presentations at different scales and maps with different value intervals. Publication of maps in grey tones (black-and-white) is paramount: colour maps can only complement the black-and-white ones.

   The scale of magnetic intensity value or the earth resistivity value must be plotted on the map.
4. Interpretation. The first stage of interpretation should include a description of the given map, ie pointing out of the anomalous areas. This ought to be followed by an attempt at extracting information of archaeological nature, which involves connecting particular anomalies with archaeological objects or else either stating the absence of such relations or emphasising that the existing ones are open to doubt. A graphic interpretation will be useful: contours of suggested archaeological structures imposed onto the magnetic map. The interpretation should indicate whether the observed anomalies have or have no connection with surface landforms.

Krystian Kozioł, Jerzy Czerniec, Bartłomiej Bęgziak, Roman Orlikowski

Geospatial inventorying system of the Archaeological Photo of Poland (AZP): the case of the Chełmno region

Summary

The Archaeological Photo of Poland (AZP), a research and conservation project, was set up following years of experience in surface archaeological surveys. The beginnings of field prospecting in archaeology go back to the 19th c. when the discipline's founding fathers were active in Poland. Many scholars grouped in historical societies collected data about artefacts, often making sketches or plans. The development and professionalization of archaeology was accompanied by the growth of methodological background and advance in field prospecting methods (Tunia 1997). In the 70s of the last century the body of archaeologists adopted general principles of documenting the inventory cards of an archaeological site, which after a few modifications have been in effect since 1978 (Konopka 1981). As a result over 80% of the country's surface has been examined: over 400 000 nonportable objects were discovered, more than a half of which are traces and settlement points of small spatial range, with the remaining ones revealing sites connected with settlement, defence, burial, production or cult (www.NID.pl 2011). The INSPIRE directive requires the EU member countries to work on obtaining spatial data necessary for the protection of a country's archaeological resources. As part of pilot activities the creation of the AZP cards inventorying system with the use of GIS tools has been undertaken.

Artur Buszek

Magnetic prospecting at the site Wielka Wieś 25, Tarnów district

Summary

The site Wielka Wieś 25 (AZP – Archaeological Photo of Poland – 105-65; 68) and Wielka Wieś 26 (AZP 105-65; 69) are located about 3 km south of the town of Wojnicz in the Tarnów district. Due to the planned road investment that was to cut across the two archaeological sites salvage explorations had to be carried out in advance of the road construction. A detailed reconnaissance of the sites being absent, a geophysical prospecting at the site Wielka Wieś 25 was decided. Because of the considerable infrastructure density at the Wielka Wieś 26 area, in this case researchers chose not to conduct such studies at the site.

A fluxgate gradientometer from Geoscan Research, model FM 256, with measurement resolution of 0.1 nT and measurement time of 0.1 second was used in the examination.

The magnetic map shows both a succession of point anomalies roughly circular or oval in shape and line anomalies. Some of the anomalies are connected with contemporary infrastructure above and below the ground. Line anomaly is particularly manifest and corresponds to the gas pipeline running at the area. In contrast, point anomalies (except for those with extreme high value amplitudes) can be linked with archaeological objects.

The results of geophysical prospecting have been confirmed and verified by excavations. At both sites materials dated to V Bronze /Hallstatt C and the Younger Pre-Roman Period were documented. The Wielka Wieś 26 site has been unfortunately much destroyed by previous investments. Wielka Wieś 25, with Przeworsk culture (Younger Pre-Roman Period) artefacts predominant, has been preserved in a much better condition. Over 100 hearths, huts and posthole pits have been identified at the site.

Magnetic prospecting at the Wielka Wieś 25 site has allowed to identify an archaeological site and thus played a major role in the scheduling of excavations prior to the road investment. The most important task was locating point anomalies connected with the hearths because, due to the absence of pottery material and other portable objects, the area showed no sign of objects or archaeological layers during surface surveys.

Agnieszka Przybył

Non-invasive archaeological prospection for the protection of the archaeological heritage of forested areas: the example of the Muszkowice Forest

Summary

The primary aim of this article is to present the potential of applying modern non-invasive methods for the protection of the archaeological heritage of forested areas. This is achieved by using the example of the study conducted in 2012 in the Muszkowice Forest, which is located between the villages of Piotrowice Polskie and Muszkowice in the Sudeten Foreland (Lower Silesia Province). The presentation of the study results is preceded by a brief look at the history of the identification of archaeological sites in the forest. Next, the course of the non-invasive research is characterised with the description of the methods and tools used (airborne laser scanning LIDAR/ALS, verification surface survey and geomagnetic survey, analytical tools of GIS). The results of the non-invasive prospection are summarised by showing the possibilities which have been created by the application of modern techniques and technologies of measurement data acquisition and processing in activities planned for the protection of archaeological heritage.

The interest in the area under discussion, located in the loess zone of the Sudeten Foreland, was triggered by the need for a thorough recognition of the geographical, settlement and cultural context of the Neolithic cemetery with long earthen barrows – Muszkowice, site 18 (Ciepłowody Commune, Ząbkowice District). The excavations on the site were carried out between 2002 and 2005 and between 2010 and 2011, while its discovery caused a great commotion among the Polish researchers of the Neolithic. This was mainly due to the previously-held conviction that such relics were not present in the upland areas of south-western Poland. Researchers had believed the lack of monumental cemeteries in these areas to have been an expression of different funerary practices of local communities, practices that made those people different from the representatives of other Funnel Beaker culture groups who inhabited other areas of Poland and erected long earthen barrows of the "Kujavian" type.

The conducted archive research and field prospection indicated the possibility that seven sites that included earthen barrows of various proportions could be present in the area of the forest – these were presumed to have been prehistoric and early medieval cemeteries. However, surface surveys conducted in 1984 and 1990 within the Archaeological Record of Poland project resulted in identifying the location of only four of all the cemeteries shown in German archival records compiled before the Second World War.

In the spring of 2012, owing to the use of airborne laser scanning LIDAR/ALS, a Digital Terrain Model was created. This made it possible to pinpoint the location of all archaeological sites hidden in the Muszkowice Forest, each of them containing individual features. They were identified in the course of surface prospection that selected features for magnetometric survey.

The application of modern methods of prospection enabled the researchers to locate within the Muszkowice Forest a total of several dozen Neolithic megalithic monuments and prehistoric and early medieval barrow cemeteries, as well as two dykes, most probably dating back to the Middle Ages.

Some of the activities conducted within the project, aimed to contribute to the archaeological protection of cultural heritage, included identifying the precise locations of the sites, creating a comprehensive record of their inventory and documenting their state of preservation, but also identifying existing threats. Large-area, non-invasive prospection of archaeological sites together with their geomorphological context enabled by the use of ALS scanning and data visualisation tools of GIS offered a new look at the issues of cultural landscape of which the identified relics were part. This also made it possible to plan the activities for the protection not only of particular sites and archaeological features but also of the entire social space formed by them. The undertaken activities resulted in a decision being made to extend conservatory protection over the whole area covered by the Muszkowice Forest.

Marcin M. Przybyła, Piotr Szczepanik, Michał Podsiadło

Non-invasive exploration of site 1 in Gniazdowice, Proszowice district

Summary

Gniazdowice is located on the Proszowice plateau situated in the southern part of the Niecka Nidziańska depression. Site 1 lies on a loess headland jutting into the Szreniawa valley. Limited salvage excavations conducted in spring 2011 discovered remains of a ditch containing Neolithic pottery. A number of aerial photographs of the site taken later in summer revealed vegetation and soil markers related to numerous objects surrounded with a ditch (Figs 2, 3, 4). In autumn 2011 and 2012 geophysical research and surface survey were carried out. Magnetic survey was done with the use of fluxgate Foerster Ferrex 4.032 DLG magnetometer. It showed a series of anomalies indicative of a fortification system consisting of two ditches and numerous objects enclosed within (Figs 5, 6, 7, 8). Next a few electrical resistivity soundings were performed along the profiles of both discovered ditches, using the ADA-5MP meter produced by ELMES. It allowed to define the contour and depth of the ditches surrounding the settlement (Figs 9, 10).

Parallel surface survey delivered 106 finds of characteristic pottery fragments and many flint objects. Similarly to the pottery found during salvage excavations, the bulk (88%) represented the Funnel-Baden culture (Figs 12, 13: 1-7). The reach of pottery found on the surface overlapped with the area contained within the fortifications, which suggests that a vast fortified settlement was discovered in Gniazdowice (Fig. 11). The southern section of site revealed a concentration of finds connected with the Mierzanowice culture from the Early Bronze Age, which include pottery fragments and shell beads (Fig. 13: 8-13). A fragment of a human skull was also found. The area probably held an Early Bronze Age cemetery. Magnetic surveys have shown a series of anomalies that might be connected with the object .

Roman Křivánek, Arkadiusz Tabaka

Non-invasive research in Ostrów Lednicki

Summary

Ostrów Lednicki is the largest isle on the Lednica lake in central Wielkopolska. At the beginning of the 10th c. a small fortified settlement was erected there, and after rebuilding (and considerable enlargement) about mid-10th c. it became one of the major residences of the early Polish state.

About mid-11th c., following a makeover of the palatial and sacral constructions and reconstruction of the settlement church and the ramparts, Ostrów Lednicki became the capital of the castellany (administrative unit). In the suburbium (*podgrodzie*) human settlement developed dynamically until the turn of the 12th/13th c.

The beginnings of the modern age interest in Ostrów Lednicki date back to the 40s of the 19th c. but more intensive research started only in 1856. The last several decades have seen mainly architectural examination of the palatial-sacral complex, the settlement church and constructions. Despite their limited scope the excavations in the suburbium allowed to capture dwelling objects of considerable size and numerous hearth indicative of a long-lasting use of the settlement. Non-invasive research to better recognize the site's layout and to capture its road network was decided upon. With this aim in mind in 2010 a Czech-Polish research project "The stratigraphy of selected fortified settlements of the oldest Premyslid and Piast states in view of comparative non-invasive research" was set up to supervise and compare the results of the explorations.

During non-invasive work in Ostrów Lednicki the researchers applied measuring apparatus used by the Institute of Archaeology, Czech Academy of Sciences. Magnetic measurements in the years 2009-2011 were carried out with a caesium magnetometer Smartmag SM-4g (Scintrex Ltd., Canada) on a measuring grid ca 1x0.25 m (more precise figures were obtained with a grid ca 0.5x0.2 m). In 2012 a five-channel magnetometer DLM-98-ARCH provided with a wheeled chassis and level gradient meters FMG-650B (Sensys, Germany) with the measuring grid 0.25x0.1-0.2 m was employed. For electrical resistivity studies RM-15 apparatus (Geoscan Research, Great Britain) was used, with the measuring grid 1x1 m, in Wenner array: A0.5m M0,5m N0.5m B (with a shallow reach down to 0.5 m in depth).

Both the area and methods of geophysical research of the early mediaeval fort and dwelling settlement in Ostrów Lednicki were chosen with regard to the specificity of the location – an isle at the middle of the lake. The selection of methods took into account the possibility of disturbances following many previous archaeological examinations and other modern-day adaptation of the territory. Magnetic prospecting was first and foremost aimed at estimating the nature and intensity of human settlement and monitoring potential "linear" objects as well as objects with an accumulation of hearths. A particularly large number of objects was registered on the terrace, in the suburbium (*podgrodzie*) in the northern part of the isle.

The aim of electrical resistivity measurements was to follow the situation in the *podgrodzie* along the western shore of the lake and the south-western, southern and south-eastern sections of the fort's ramparts as well as to identify the sub-surface remains of stone constructions linked with the settlement that existed on the isle, with the rampart and the relics of a road.

Intensive human settlement traces were registered on the flat terrace in the northern part of the *podgrodzie*. Juxtaposition of the magnetometer measurements results with those of geoelectrical resistivity suggests a number of possible orientations for situating archaeological objects. A correct interpretation of the readings is at times constrained by a considerable accumulation of the remains of hearths or metals. This however might constitute one of the guidelines "revealing" the remains of the road network.

Local distribution of magnetic anomalies reflects the activities linked with distribution of metals, soil cultivation or may indicate sites of earlier archaeological explorations.

Along the western shore a sub-surface strip of stones was discovered; it may be interpreted as the remains of a destroyed road or stone remains of the shore reinforcement at this particular part of the isle. Results of electrical resistivity measurements along the southern section of the fort's embankment reveal the place of a probable gap in the wall – the original entrance to the fort. At the present stage of archaeological research and geophysical measurements some other possible interpretations of the results could be proposed as well as at least two variants of the location of the fort's entrances - from the southern or south-northern side.

The research results have contributed a considerable body of knowledge about the area formerly untouched by excavations, for instance the attempt to map out the track dissecting the *podgrodzie* (suburbium).

Krzysztof Misiewicz, Miron Bogacki, Wiesław małkowski

Integration of data from non-invasive archaeological research: the case of Asparos (Gonio) fortification, Georgia

Summary

Non-invasive research of the Asparos fortification was carried out with the aim of determining the most promising sites for further excavation work. Another task was the creation of a model of integrating the data obtained by non-invasive methods. The measures involved kite-driven photo-taking, altitude measurements and geophysical prospecting with the use of the magnetic method. On the basis of the obtained photos and with the application of the photogrammetric method a digital surface model and a high-resolution orthophotomap were constructed. Next, the acquired data were integrated with the results of magnetometric research (in the form of maps showing the distribution of the values of magnetic field intensity) and with terrain topography measurements. The whole body of data was registered in the universal Mercator coordinate system (UTM, zone 37). The correlation of the above mentioned methods permits the researchers to achieve the most complete information possible about potential archaeological artefacts and their multidimensional interpretation.

Jerzy Sikora, Piotr Wroniecki

Geophysical survey as an integral part of research in archaeology. The case of the settlement microregion in Ostrowite

Summary

Archaeological research in Ostrowite, Chojnice *gmina* and district, has been intermittently conducted since 1993 by archaeologists from Łódź and Toruń universities. Next to large-scale excavations and underwater research a wide range of non-invasive archaeological research methods have been employed. A great boost came after the implementation of the Ministry of Culture and National Heritage project, Priority 5 "Preservation of archaeological artefacts": "Non-invasive research in the Ostrowite lake area", carried out in 2012 by the Polish Archaeologists Scientific Association, Łódź Division . The methods included aerial archaeology (photos from planes and unmanned airships), magnetic and resistivity surveys, intensive surface surveys by analytical methods, and geochemical surveys (phosphorus method). Parallel with these studies took place a geological and geomorphological reconnaissance of the Ostrowite lake area which abounds in settlement complexes elements from the beginnings of the Iron Age and the Pomeranian Culture, the Roman Period and the Wielbark Culture and the Middle Ages (from the second half of the 11th to the close of the 13th and early 14th c.). Given such a vast set of data there arose the problem of their appropriate integration. It was decided that the best procedure would be feeding them into the data base of the GIS (Geographical Information System). The software accessible under Open Source licence, Quantum GIS, gvSIG and SAGA GIS, was used.

Mutually verifying and complementary, research methods also helped to discover hitherto unknown spatial structures. An important discovery were the remains of a previously unknown defensive object connected with the mediaeval stage of the area's settlement. Recognised by aerial, geophysical and excavation methods and indirectly by geochemical and surface surveys, the object had no field form and remained undetected over the decades of archaeological exploration of the Ostrowite complex. Its discovery and basic survey were made possible precisely by the use of survey methodology on such a great scale. Considering the perspective adopted during Ostrowite research, geophysical studies were not a target per se but only one among many tools available to archaeologists. Integrated within the GIS they permitted a reconstruction of the spatial settlement development in consecutive chronological horizons.

Fabian Welc, Radosław Mieszkowski, Janusz Budziszewski, Jacek Wysocki, Sebastian Kowalczyk, Cezary Nalazek

Applicability of ground-penetrating radar method (GDR) in non-invasive archaeological prospection: the case of three site types in Poland

Summary

The aim of the article is a presentation of preliminary results of georadar exploration at three different archaeological sites: prehistoric flint mines in Borownia and Seredzice, and relics of the church mediaeval architecture in Opatów. The project has been jointly implemented by the Archaeology Institute, Cardinal Stefan Wyszyński University, and Geology Department, Warsaw University. The principal target is establishing the most effective procedures of georadar prospection of archaeological sites of diverse types, and of processing and interpretation of the obtained results, with particular emphasis on 3D modelling.

During geophysical studies the radar system RAMAC GPR produced by a Swedish company Mala Geoscience was employed. The prospection was conducted with the use of shielded transmitting antennas with nominal frequency of the emitted electromagnetic wave, correspondingly, 100, 200 and 500 MHz. All profiles produced were processed by professional software Ramac Ground Vision and Reflexw-Win of the German company Sendmeier Software.

Directly west of Iłża in the Seredzice village (*gmina* Iłża, Radom *powiat*, Mazowsze voyvodship) there lies a prominence the core of which consists of Upper Jurassic (oxfordian) monadnock containing rich deposits of chocolate and striped flints, described in the literature as the "Hapki" site. As the depth of the flint occurrence in the area was unknown, georadar measurements were carried out with two shielded 100 and 150 MHz antennas. The comparison of the echograms produced by the two antennas shows that the image obtained by the antenna with frequency of 250 MHz displays a much better "resolution". The form of reflecting surfaces, or reflectors, is plotted with greater precision despite only slight reduction of the prospection depth in contrast with the profile obtained from the 100 MHz antenna. High-quality profiling results achieved with the help of the 250 MHz antenna were mainly due to the fact that the objects examined were located at a small depth and were buried in solid limestone rock, a centre which little absorbs electromagnetic waves.

The "Borownia" site in Ruda Kościelna (*gmina* Ćmielów, Ostrowiec *powiat*, świętokrzyskie voyvodship) was discovered during joint surface survey carried out in September 1921 by S. Krukowski and J. Samsonowicz. The prehistoric mine field "Borownia" stretches in a landbelt 30-50 m wide for over about 700 m SW of the Kamienna river. It has the form of a bank of limestone rubble, of small height, demonstrating clearly visible spherical slag heaps with funnel-shaped depressions of mineshafts in the centre. Georadar research of the "Borownia" site was conducted in 2011. One of its primary aims was to discover the way radiograms present the mineshafts bored in the rock and their radiating horizontal exploitation galleries.

The characteristic anomaly n in the obtained echograms allows to presume that several mineshafts of different depth have been documented, with the deepest one at about 8 m. Below the shafts strong reflexes, possibly generated by the roof sections of the exploitation galleries, can be observed. In a few places diagonal reflexion lines generated by the bedding of the limestone massif, reflecting the apparent dip of rock strata, are manifested.

The georadar exploration conducted at site 1 in Opatów was of somewhat different nature. The site is identified with Żmigród, a 13th c. settlement well known from historical accounts. Apart from the excavations carried out at the site of the former settlement in spring of 2012 (the work was headed by Jacek Wysocki Ph.D., Archaeology Institute, Cardinal Stefan Wyszyński University), geophysical studies were done in the small courtyard located at the area neighbouring with the excavations at the Bernardine monastery

The results of the GPR prospecting have significant scientific implications: they indicate the presence in the area of at least two architectural structures that chronologically precede the monastery church, the beginnings of which date to the 15th c. According to J. Wysocki, test excavations and GPR prospection results allow to accept a thesis that the anomaly with the working label R I is the oldest, ie 11th c. church construction erected in Opatów.

To recapitulate: it can be stated that the geophysical prospecting carried out in Seredzice and Borownia has confirmed the high usefulness of the georadar method in non-invasive examination of prehistoric mine fields, in particular with the application of the 250 MHz antenna. It must be emphasised, however, that the considerable depth range (down to 10 m) obtained during the research and the high resolution were to a large extent caused by favourable geological conditions, namely, the sharp dielectric contrast between the massive compact limestone on the one hand, and lithologically varied Quaternary stratum and debris deposits filling the mineshafts and the underground exploitation galleries on the other.

The results for Opatów, where the georadar was employed for examining the relics of the early mediaeval church architecture, are also interesting. In contrast with Seredzice and Borownia, the 500 MHz antenna was used and it proved its effectiveness for the study of archaeological sites as well.

Marcin Dziewanowski

State-of-the-art report on the research of Funnel Beaker culture polyhedral tools in Pomorze Zachodnie (Western Pomerania)

Summary

The paper presents the preliminary results of exploration of sources for studying polyhedral flint technology in the Baltic community culture from the 2nd half of the 5th millennium BC to the beginning of the 3rd millennium BC. It follows from preparations of the report "*Middle and Late Neolithic flint working in the Lower Odra region*".

The main thesis of the first section of the text is the assumed existence of a south-western Baltic flint production centre that covered the area of Lower Odra river and partook in interregional cultural information exchange.

The second section focuses on the possibility of creating a multifaceted picture of changes within the flint production system as part of cognitive studies at individual and holistic levels. The framework for such studies is set by the existing knowledge of sources and a generally sophisticated reflexion on the subject in neighbouring territories. Three stages of flint working technology have been distinguished within the culturo-spatial classification of cultural phenomena. The first stage covers phases A and B of the Early Neolithic in northern systematics, ie Proto-Neolithic communities and older phases of the Funnel Beaker culture that developed new tools for wood working. The second stage is connected with pottery stylistics of phases B and C of the Early Neolithic and the beginning of Middle Neolithic. This period saw the development of regional groups showing distinct features in terms of material culture, and in successive centuries this culture's Odra centre emerged, reflected in evidence of polished axes production and use as revealed by research. The third stage is linked with the Late and Epibeaker period which witnesses a culmination of systemic changes readable at the level of source examination. At that time the Funnel Beaker and Globular Amphorae cultures merged and a new cultural system developed. Corroboration of axes production and use became a general and distinct component in archaeological inventories connected with the Late Wiórek and "Ustowo" phases.

The third section presents research perspectives and suggests directions for Neolithic flint working exploration through conceptual and field studies that would build up a dynamic and multilevel model illustrating the specificity of flint material industry in communities producing and exploiting flint ground tools.

MATEUSZ CWALIŃSKI

The influx of amber to circum-Adriatic areas during the Bronze Age. Proposition of interpretative model

The significance of amber finds for the research on intercultural relations in the Bronze Age Europe has been discussed by archaeologists for a long time. These considerations have resulted in several concepts describing the methods and routes of inflow of this raw material from the Baltic shore to the centers of the Bronze Age civilizations located in Italy and Greece. The discussed roads are conventionally called "amber routes". In the opinion of many scholars the Adriatic route was very important in a broader historical context. The aim of this article is to present the most possible complete characterization of the current state of knowledge on the Bronze Age amber finds from the Adriatic region. The emphasis is placed mostly on the scope and distribution of amber artefacts in relation to the cultural characteristics of different regions and sub-regions. On the basis of existing typologies and chronologies, the author discusses typological variations of artefacts both with regard to time and space. The article presents specific structures of distribution of selected objects and shows their strong correlations with other categories of artefacts. All the above considerations are described in the context of theories and interpretations of different scholars. Finally, the conclusions include the outline of a new interpretive model, which links archaeological sources with cultural phenomena associated with "the Adriatic branch of the amber route".

Ahmed Ali Elmirghani

The case of Haraz cemetery on the background of historical and cultural context of 4th and 5th century in central and northern Sudan

The cemetery at Haraz is a representative site of a cultural unit known for years as the post-Meroitic culture. It is located in northern Sudan in the vicinity of the Fourth Cataract of the Nile, and it includes 296 graves. The excavations were carried out within its northern part, where 262 features were recorded. The research involved mostly collecting, and thereby saving the largest possible amount of data due to the upcoming completion of the Merowe Dam and flooding of all the area. The author of the article discusses the methodology employed during excavations, addresses the issues of location of settlement sites associated with the cemetery at Haraz and describes examples of artefacts found there. Since the area under discussion has already been flooded, the results of the research should be regarded as the last glimpse into the past of this region. In addition, the author attempts to analyse intercultural relations between the post-Meroitic culture and other cultural units from the fourth and the fifth centuries in central and northern Sudan.

MARIUSZ DRZEWIECKI, BEATA DRZEWIECKA, MONIKA ELEČKOVÁ

Diffi on Jawgul Island (3rd Cataracte, Sudan)

Summary

Diffi is a Nubian term naming remains of post medieval (XVI-XIX Century) fortified sites in northern Sudan. Large accumulation of those building can be observed in the Nile Valley between 2nd and 3rd Cataract. An example of this is Jawgul Island where, within one village, two diffi structures have been recorded. Due to those building being visible in the landscape and being still in use, archaeological as well as ethnological methods are combined to answer question of their present and past meanings.

For people living in Jawgul this is their heritage, proof of settlement continuity, symbol of authority and remains of signaling system used for protection of the villagers. Architectural and small finds analyses are apply to enrich the narration and to verify those generally accepted opinions. Two diffi have been built in different times (western diffi between 16th and the beginning of 19th Century and eastern diffi in 19th Century), using various methods and techniques as well as on diverse locations. Eastern diffi with possible remains of prison just outside, could have been a seat of omda (village head) responsible in 19th Century for tax collection on behalf of the Ottoman authorities. This diffi was equipped in loopholes giving some degree of defensive possibilities while both diffi could have been effectively used for signaling system installation.

Project is in progress but assumed connection between the present and post medieval settlement in Jawgul have been confirmed.

Jacek Kabaciński, Iwona Sobkowiak-Tabaka

Flint production of the Late Banded Pottery culture community at site 12, Międzyrzecz

Summary

In 2010 and 2012 at site 12 in Międzyrzecz salvage excavations were carried out ahead of the construction of the second, northern lane of Międzyrzecz's ring road (Fig. 1). The work provided documentation of the remains of Neolithic settlements identified with Late Banded Pottery culture (LBPC) communities and penetration of the area by communities presenting Funnel Beaker culture (1 pottery fragment) and Corded Ware culture (1 pottery fragment) as well as traces of a transitory period between the Neolithic and Early Bronze Age (2 pottery fragments). Settlement remains of communities related with the Lusatian culture, Early and Late Middle Ages and the Modern Age also appeared.

The remains of LBPC settlement presented by 9 features, 715 pottery fragments (Seroczyński 2012, 2012a), 4 stone tools (Jórdeczka 2012), 334 flint artefacts, 390 bone fragments (Osypińska 2012) and 169 lumps of daub were all concentrated in the southern section of the site, scattered over an area of 5 ares. The first concentration of objects was registered within the are A7, are A17 and are A28 with 2 dwelling objects A60 and A62, 2 utility objects A64 and A65 and 1 posthole (Seroczyński 2012a). The second concentration of objects was discovered in the are A34 and are A44, where an object used as a dwelling (A23), 2 utility objects (pits – A26 and A29) and a posthole A14 (Seroczyński 2012, 2012a) – cf. Fig. 2.

This paper presents in detail the flint production of LBPC. It is the first fully homogenous and so abundant Late Banded flint assemblage from the Ziemia Lubuska (Lubusz Land) region.

Flint artefacts, an assemblage of 334 specimens, were registered in 6 multifunctional archaeological objects found in the functional stratum connected with the operating of objects A60 and A62 and within trench A34b (Tab. 2; Figs 3-9). Material-wise, all artefacts were made of the erratic Baltic flint.

The largest specimens reach up to 63 mm in length, but none of the cores exceed 50 mm. In many cases the cores are fragmentary and hence the specimens used at the site by the LBPC communities most probably did not exceed 8-10 cm in length. The presence of small-sized fragmentary forms prove the lack of access to good quality raw material.

The small number of specimens from the core preparation stage, preliminary preparation and early flaking stage shows that material was worked at the site.

Flint material knapping at the site almost exclusively involved the classic coring technique (Tab. 3). The splintering technique played only a marginal role. The main objective of flint production were blades which are slightly more numerous than flakes (Tab. 3). Tools were made largely from flint blanks. 4 types predominate: scrapers, flakes and retouched blades and truncated blades (Tab. 4), with only single specimens of the remaining types, ie perforators, combined tools, trapezes.

One absolute age designation of the object which yielded the largest flint collection (164 specimens) was obtained for the analysed assemblage. Radiocarbon analysis of an animal bone deposited in object A60 put the sample's age at 5550 ± 35 BP (Poz-48883), which allows to place the LBPC settlement at the close of phase IIa and the beginning of phase IIb of the culture's development in Kujawy (Czerniak 1980).

Taking into consideration the fact that the material used was in 100% erratic Baltic flint, it must be stated that the assemblage under discussion belongs to the Lowland type of LBPC flint exploitation. At the Międzyrzecz site, however, mainly the classic coring technique was applied (99.1% of the whole assemblage), while the participation of the classical and splintering techniques at other LBPC sites from the pertinent LBPC development phase is fairly balanced (Kabaciński 2010, p. 152; Fig. 10). On the other hand, the kind of blanks, execution technique and the tool structure of the analysed assemblage is typical of the LBPC phase II assemblages in Wielkopolska and Kujawy (Fig. 11).

Flint analyses demonstrate that in terms of its material, technological and typological structure the studied assemblage reveals a marked similarity to LBPC sites in Wielkopolska and Kujawy.

This is the first closed LBPC flint assemblage from the Ziemia Lubuska region, the westernmost great valley zone of the Polish Lowland, whose significance is emphasised by its radiocarbon dating.

Magdalena Stasiak, František Trampota

The Funnel Beaker and Lusatian culture vessels from “Filehne, Westpreussen” of the von und zu Liechtenstein family collection in the collections of the Regional Museum in Mikulov

Summary

The paper presents archaeological artefacts from ”Filehne, Westpreussen” (modern Wieleń, gmina loco, Czarnków-Trzcianka powiat, Wielkopolska voyvodship), today in the collections of the Regional Museum in Mikulov (Regionální museum v Mikulově). The five objects which include one Funnel Beaker artefact and four ascribed to the Lusatian culture had been probably part of the antiquities collection of the Moravian branch of the von und zu Liechtenstein family. They were transferred to Mikulov from the closed down Valtice museum, Břeclav district, along with other exhibits. Unfortunately it was impossible to establish how the said objects found their way from Wieleń to Valtice.

Przemysław Makarowicz, Aldona Garbacz-Klempka

Metallurgists' settlement in Szczepidło on the middle Warta. Some remarks on bronze objects industry in the 2nd millennium BC

Summary

Ten years of field studies (excavations and non-invasive surveys) on site 17 in Szczepidło, gmina Krzymów, Wielkopolska voyvodship (Figs 1, 2) conducted by the Institute of Prehistory, Adam Mickiewicz University, Poznań, have documented spectacular remains of Bronze Age human settlement.

One of the most fascinating phenomena legible throughout the functioning of the settlement was the adoption of bronze metallurgy and a substantial development of bronze objects production. Comparative analysis of pottery and bronze objects stylistics as well as radiocarbon dating sequence estimates allow to place the start of the metallurgist workshop within the 1350-1150 BC framework and link it with the activities of a community from the late stage of the Trzciniec culture with Tumulus culture and Lusatian culture features. A presentation of some aspects of metallurgical production by the settlement's inhabitants is the primary aim of the present paper.

Traces of metallurgical activity were mainly recorded in the central and southern sections of the area explored by excavations and metal detectors (Figs 3-5). The products were registered at various depths – both in humus and in layers situated beneath, as well as in the features. They were mainly registered below the modern humus stratum in feature 153 (including 153A and !53B) – 37 specimens – and its vicinity, and also in features 99, 160, 165, 192, 193, 215, 240, 248, 252, 255, 256 and 286.

The analysis of the spatial distribution of all bronze objects disclosed their main (original) concentration in feature 153 assumed to be a metallurgical workshop (Fig. 5). The central features described was a dwelling with a sunken floor but without remains of postholes (Fig. 6). For this reason it is hard to define the structure type and the technology of its construction. The feature was formed as an irregular polygon oriented along the NW – SE axis; it was 13.2 m long, 10.3 m wide, with maximum depth of 1.04 m. The multilayered hollow-shaped fill-in with an uneven bottom was made up of components of the humus at varying degree of podzolisation and unpodzolised humus mixed with yellow fine-grain sand. Traces of burning and charcoal concentrations were traceable at different depths.

The basis for classifying the feature as a dwelling-production construction was the above mentioned vast pottery fill-in (over six thousand fragments of several hundreds of vessels) attesting a long-lasting exploitation of the area. Abundant traces of burning, broken up charcoals, burnt vessel fragments and an assortment of (damaged) bronze objects, smelting, runners, slag, crucibles, spoons, lumps of metal and burnt stones testify to an intensive and probably continuous bronze objects production over a longer period of time. A considerable concentration of portable material has been recorded around the described feature, particularly west and east of it. Distribution of metallurgy traces suggests that the entrance to the workshop led in the easterly direction. (Fig. 4). It's plausible that the workshop was "openwork" or half open – it had low walls which allowed a spontaneous offtake of harmful gases and steam.

Outside the central zone a smaller concentration of the metallurgical production remains was found in the southern section of the excavated area (Fig. 5).Smelting fragments and bronze objects were registered in features 214, 215, 248, 252, 255 and 256 lying next to one another and in feature 240 situated slightly to the north (Fig. 7). The possibility of their being used in the metalworking is supported by their dark coloured (deep dark brown or black) fill-ins, traces of burning and charcoals. Shallowly beneath the humus layer infrequent slag lumps have been recorded. Between the metallurgical workshop (object 153) and the concentration just mentioned there occurred numerous traces of smelting, fragments of objects and slag, mainly in the arable layer. Their planigraphy, however, is a consequence of frequent surface relocation of soil layers (secondary distribution).

Site 17 has yielded 140 bronze objects altogether: finished products, half-baked products, products of smelting ("tears/drops"), remains of the production process (runners) and raw material lumps. A large series of slag (80 specimens) and a few chiselling tools have been registered. The finished products, in most cases damaged or unsuccessful and often corroded, included pins and small arrowheads (Figs 8, 9).

The remaining objects, preserved only in pieces and *de facto* forming scrap metal, are half-baked products/semi-finished products or production waste left over from jewellery making (bracelets, pins, pendants, etc), weapons (arrowheads?) and tools (a razor or a small knife). These were mainly registered in object 153 and its vicinity as well as - in smaller quantities – in the southern section (Fig. 10) of the surveyed area.

Fragments of runners or technological remains of bronze objects casting have been registered in the analysed material. A few such objects with characteristic funnel-like shape have been recorded (Fig. 11).

The most numerous category of metal objects from Szczepidło are small bronze runners (drops 1 – 3-4 mm in "diameter" and lumps) and larger ones (up to several cm) which are the by-products of the metalworking (Fig. 12). In the area examined, mainly in object 153 and its vicinity, over 80 specimens of various size and shape have been registered.

The body of sources contained 82 lumps of bronze slag. They varied in size and were in most cases much vitrified (Fig. 13). They rarely occurred below the humus and were most frequent in modern-day humus, which must have been due to their small weight and susceptibility to transfer during ploughing.

In various zones of the site, mainly in the workshop, in its vicinity and in features situated in the southern section of the examined area fragments of small crucibles and casting spoons were registered (Figs 16-18). Traces of burning, smoking and visible - macroscopically at times – drops of metal signify to their use. Small fragments of at least several crucibles have been recorded; only in one case almost whole container has been reconstructed. Very small fragments of at least two spoons have been found as well.

The northern section of the site besides features (effect of ploughing?) chiselling tools connected with the finishing stage of metal processing have been recorded. They were polishing stones, hammers/small anvils and also "whetstones" (Fig. 14).

The examination of the metal collection from Szczepidło involved a laboratory analysis of 51 artefcats – leftovers of the metallurgical workshop. They were divided into two sets: finished products and fragments allowing a reconstruction of the metallurgical process. Three separate artefcats groups were isolated within the second set: production waste and raw material, crucibles and pottery, and slag.

The objects were described in terms of their structure and chemical composition. The research included macro- and microscopic metallographic analyses (optical and scanning microscopy), chemical composition analyses by X-ray fluorescence methods, SEM microregion analyses by spectrometric method and a phase analysis by the X-ray diffraction method.

The material examined – raw material, fragments of crucibles and scrap bronze i.e. runners, gating systems and destructs as well as the few finished and undestroyed, well prepared objects, slag and chiselling tools – shows irrefutably that at site 17 in Szczepidło an advanced foundry from the 2nd millennium BC has been discovered, an object unique in Central Europe. All the elements coming together testify to production processes there performed. Their only fragmentary preservation and absence of workshop equipment such as a furnace or hearth do not allow a more precise account of either the size of the workshop or of production. Still it can be assumed that the foundry produced small, carefully cast objects, among them ornaments and arrowheads.

The objects were cast in red and leaded bronze, though some of half-baked products revealed a very atypical composition (Fig 15, Tab. 1 and Tab. 3). The site yielded no pure raw material (copper and tin) except for lead whose source can be ascribed to its local (Śląsk – Kraków) provenience from zinc-lead deposits with silver admixture, which had been exploited very early on. Some examined objects reveal a high lead content which might indicate an intentional addition of the element changing slightly the technological properties of the products and thereby modifying the alloys made directly in the workshop.

The discovered gating systems, or more precisely main runners (funnel-shaped mapped from the mould) broken off the finished products must surely prove that the casting was done on the spot and directly confirm the composition of the casts made. In view of the absence of stone moulds at the site, it can be accepted that clay moulds had been used. This is corroborated by the characteristics of the finished products which carry no casting welding seams which usually came from divided stone moulds (although they might have been ground during the finishing process). Runners not submitted to processing do not show any seams either, due to their waste-like nature.

Finished products carry traces of processing by different techniques. Casts reveal effects of hammering, grinding and polishing aimed at technological processing with chiselling tools to remove defects and aesthetic processing to improve the decorative value of the objects.

Dimensions of the crucibles used in the workshop are unknown. Following the rule that crucible size corresponded with that of the finished cast together with the gating system, the capacity of the crucibles may have been approximately 10-15 ml. Drops of metal present in the crucibles indicate the composition of the alloy used in the workshop.

From the point of view of the development of metallurgy and casting in the Vistula and Odra basin the discovery of the Szczepidło workshop is a most important one and provides major information concerning technological production of bronze objects. Despite numerous finds of finished products in hoards and graves and of casting moulds recovered from the furnishings of the so-called casters/smiths there is still a shortage of comprehensive and exhaustive data about the organisation and production in a Bronze Age metallurgical workshop. The research of the remains of casting workshops are of major significance and provides important source materials for archaeology as well as for production technology and materials science.

Wojciech Dzieduszycki

Multicultural site in Wierzchaczewo, gmina Kaźmierz, Wielkopolska voyvodship In the light of archaeological and natural environment studies

Summary

The rescue excavations on site 2 in Wierzchowo, *gmina* Kaźmierz, Wielkopolska voyvodship, have produced valuable data about natural environment and cultural transformations in the region. Noteworthy is the attempt to capture the relationship between natural environment changes and the dynamics of cultural transformation.

During meticulous analysis of archaeological sources and their distribution in geologico-biogenic-cultural strata of varied character conclusions about the type of the site's human exploitation over a long time sequence, ie from the Neolithic until the Modern Age, have been formulated.

Geomorphological analysis of the area demonstrates that following the retreat of the last glaciation there were formed smallish endorheic (still) water bodies during the withdrawal of the ice-sheet in which organic remains accumulated, forming stratigraphic arrangements, and clearly visible aeolian forms and moraine boulder clay layers.

A more detailed analysis of excavated materials has revealed that the first penetration of human groups into the area happened in the Younger Stone Age (object no. 11). Their traces are flint objects stuck in the base slice of the organic layer deposited in the former postglacial still water body. At that period the territories near the site were exploited by culturally varied human groups.

Next traces of penetration can be connected with the Lusatian culture population and possibly Pomeranian, with their settlements situated at a certain distance from the site. As confirmed by the discovered artefacts, the inhabitants were using the postglacial still water bodies in a variety of ways (objects nos 11 and 15).

Settlement of the Przeworsk culture population was of particular importance. Remains of a settlement site dated to the late Roman period have been located on the site, and in still water bodies layers material sources from that period have been found (especially in object no. 11). It can be supposed that similarly to the case of the Lusatian culture people, the still water bodies were used not just for economic purposes but served a magic and cult function as well. Their remains include deposits of peculiar forms of pottery, animal bones and daub. Water cult-related sites echoed in literature seem to support such a possibility.

A blacksmith's workshop dating back to the 12th - beginning of the 13th c. unearthed on the site was a unique find. It probably functioned on the fringe of the settlement which remained uncovered during excavations. Artefacts found in stratigraphic layers of the still water bodies discussed above indicate that workers at the blacksmith's made use of them as well.

As shown by research, at a slightly later date in the 1st half of the 13th c. there existed a small hamlet which also exploited the still water constructs.

However, during the Late Middle Ages and in the Modern Age the site lost all its original quality. Along with the more and more systematic soil cultivation documented only by few clay vessels fragments taken out with the manure, the still water bodies, overgrown with water and marsh vegetation, were regularly covered up with the arable layers. An interesting find from that period was a knife-sword dated to the 14th – 15th c.

In the Late Middle Ages, or possibly somewhat earlier, Wierzchaczewo was a knight's estate (source: 1398, *Habram de Wirchaczewo* of the Nałęcz family).

At present the area, given over to agriculture, carries no traces whatsoever of the former small endorheic water bodies.

Andrzej M. Wyrwa, Andrzej Janowski

The lower ferrule of a sword scabbard with an image of a human face from Łekno (site Ł5)

Summary

In 2007, as part of extended surface-verification surveys in the centre of the Łekno settlement complex (Łekno, Wagrowiec gmina, Wielkopolskie voyvodship) which includes a fortified settlement with a monastery (site Ł3), suburbium, the monastery dwelling settlement (site Ł4) and the so-called trade settlement (site Ł5), a few-days' work with the use of a metal detector and verifying surface excavations were carried out (2008, n2009). The main target was to determine the exact location of a hoard whose part had been incidentally discovered in 1861. During the research, confined to surface penetration, among many other artefacts a fragment of a ferrule of the lower part of a scabbard known as chape (Figs 6, 7) was found. The artefact was discovered in the humus layer in the south-western section of site B Ł5 (the southern section of zone B – cf. Figs 2 and 3).

The Łekno piece of the scabbard chape under analysis (inv. no. Ł/5/21/07 – 0Z) constitutes ca 2/5 of the original face (obverse). The other side (reverse), much damaged, is preserved only in a small fragment. The chape was submitted to an exhaustive macro- and microscope investigation, spectroscope analyses (qualitative XRF and quantitative LIBS) and CAT scanner examination.

The incompletely preserved sword scabbard ferrule from Łekno weighs 7.44 g. It was produced in the cire perdue technique. Scanner photography and microscope examination revealed no traces of hammering nor joining of surfaces with a hard solder. Precise microscope measurements have put the maximum height of the preserved fragment (obverse) at 41 mm, and the maximum width at 24 mm; the thickness of the walls lies between 0.656-0.575 mm. The face of the preserved fragment (obverse) is much worn away. Only an oval crowned with a wave motif (?) and surrounded with an openwork plaiting (?) are visible in the central part. The whole object is openwork, with the holes made/finished from the outer side in the cutting/piercing technique with a tool tipped with a triangle-like point. The tool used was placed at the angle of ca 30-45˚ to the object's surface. Scanner analysis has further revealed that some of the holes carry traces of the edge being folded inwards, which can be linked to wax being pierced with a small tool (Fig. 9), while the remaining ones could have been further cut or filed after making the cast. The holes are arranged in two elliptical lines, with the first from the outer side and the second ca 3.5 mm apart running centrewards. Particular openwork holes on the face side are from 3.75 x 2.75 mm to 2.75 x 2.35 in diameter. The oval at the centre – possibly a "bearded face" - is 14.5 mm high and 9.25 mm wide. It was made by thrusting out the centrally placed small "disc" in the object's wall. There was no repoussing. The much blurred decoration was most probably entirely made in wax.

Furthermore, there were observed – invisible to a naked eye – remains of a herringbone engraving making an edge bordure (fig 10.b) and an eye engraving made of small convex discs (Fig. 10.a). After the cast had been made the linear drawing was produced, or possibly corrected, and the whole outer surface ground and carefully polished, probably with a steel needle.

The other side of the ferrule (reverse), only fragmentarily preserved, has the maximum height of 37.5 mm and the width of 9.5 mm. It carries traces of incised lines. The outer thickness of the scabbard ferrule is at present ca 5 mm, while the inner empty space between the inside faces reaches up to ca 3 mm.

The object described has been also submitted to chemical composition measurements in the Archaeology Institute, UMK in Toruń. The process was carried out on a fragment of cleansed surface with a portable X-ray analyser XRF with an in-built standard. To lend credence to the measurement, the qualitative chemical composition was determined by the precise spectroscopy of laser-induced plasma LIBS (Fig. 11.b).The analysis has showed that the material used for the chape production was an alloy with the composition: Cu – 67.43%, Zn – 14.54% and Pb – 9.72% (.Fig. 11.a). The presence of Ca – 3.36%, Si – 3.14%, Sn – 1.01% , P – 0.70% and Fe – 0.10% was also registered, as well as Na and O, identified and unmarked on the diagram. Thus the object was made of a copper and zinc alloy, known in the Middle Ages as aurichalcum (Teofil 1998, p. 117, 120; Lehmann 1991, p. 371; P. Hammer 1997; E. Droberjar, J. Frána 2004).

Despite considerable damage and surface wear the Łekno chape can be without any doubt classified as belonging to group II in Peter Paulsen systematics (1953, p. 48-52) which comprises word scabbard ferrules with a Germanic motif of a four-legged animal (Ger. Ortbänder mit germanischen Vierflüßlermotiv) and at the next classification level to subtype 3 – chapes decorated in the Baltic animal style (Ger. Ortbänder im Tierstil des Ostseekreises) - see Figs 6, 7, 14 and the catalogue.

Taking into account the stylistic-typological analysis of the Łekno artefact presented in the paper and other objects of similar type so far found in Europe (cf. the catalogue and figs 12-20), as well as the archaeologico-numismatic context of its

discovery, it can be stated with a high degree of certainty that the making of the scabbard chape from Łekno can be dated to the final quarter of the 10th c. at the latest. It is a unique find, not just in Poland but in Europe too.

Kateriny Zisopulu-Bleja

Gothic tiles from Chwaliszewo. An attempt at an interpretation of decorative themes and the mermaid motif in particular

Summary

The archaeological supervision of the foundation trench at 69 Chwaliszewo Street, carried out in 1980, yielded numerous artefacts among which 19 Gothic tile fragments deserve closer attention. They are made of ferruginous clay coated with multicoloured lead glaze. A number of motifs was used in relief decoration: real and fantastic beasts, elements of architecture, horse riders in full dress reflecting the chivalry culture and themes referring to religious subjects. Decoding the very rich symbolic layer allowed to understand the hidden meanings of the presentations. Among others, studies allowed an interpretation of one of the more interesting motifs used in Gothic tile making – male mermaids. They are an example of mediaeval culture adapting ancient elements with a new meaning bestowed. Images of mermaids mainly served a didactic purpose and warned against the destructive influence of heretics. A meticulous analysis of the Chwaliszewo tiles supports the claim that they belong to a series of phenomena characteristic of the Gothic tile making in Wielkopolska.

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