
Contributions on:

GEOPHYSICAL SURVEY
Introduction

The Gothic Church of St. George, located in Svätý Jur (Fig. 1a), is an important example of Slovak cultural heritage. In the framework of the OPIS project this historical monument was recorded using laser scanning (Riegl VZ-400 terrestrial laser scanner) combined with precise geodetic surveying (Fig. 3). The aim of the geophysical survey was to identify potential subsurface anthropogenic features inside the church.

Microgravity and GPR methods were applied. The interior of the church was surveyed on a closely spaced grid of 351 stations (Fig. 2) using Scintrex CG-3M and CG-5 gravimeters. GPR survey was carried out along 34 parallel lines 0.2m spaced in zigzag mode over an area of 6.5×14m. A MALÅ system with a 500 MHz antenna was used, allowing a good penetration depth of up to 3m. To correct the gravity data for the gravitational effect of the massive edifice (average density of 2.2g/cm³) a simplified polyhedral model was created, neglecting architectural details and the roof (Fig. 1b).

Results from the geophysical measurements shed light on the architectural history of the church. Three crypts, predicted from historical archives, together with the west wall foundations of the Romanesque construction were detected. Combined GPR and density modelling helped to construct a spatial model of these cultural features, which is now integrated into the visualization of the visible parts of the church (Fig. 3, left). Comparing its similarities and differences can help to achieve a more accurate image of the subsurface features (Fig. 3, left down).

3D modelling of an historical building using Geodetic and Geophysical methods: St. George’s Church, Svätý Jur, Slovakia

Microgravity results are displayed in (Fig. 4). In the residual Bouguer anomaly map calculated for a correction density of 2.4g/cm³ the main anomalies of interest are two distinctive gravity lows (A−D) in the upper part of the nave (Fig. 4a). To estimate the depth and size of anomalous sources (Fig. 4b-d) the following methods are used: density modelling, Euler deconvolution (structural index one) and harmonic inversion.

The harmonic inversion provides a volume density model calculated for preselected densities. The cavities (A−C) were modelled as three polygonal prisms of an arched cross-section with a density contrast of −2.4g/cm³. The depth to the volume of these cavities is interpreted in the range of 0.5−2.3m. Fig. 4b shows a reasonable fit between the calculated and observed gravity.

The collected GPR data were processed by applying a standard steps sequence to improve its quality. From the diffraction hyperbola analyses EM-wave velocity was estimated to 0.1m/ns. Then time slices were generated (Fig. 5a). Subsequently the data were processed and visualized into isosurface volume (Fig. 5d). Finally a three-dimensional vector model was created (Fig. 5e). Fig. 5 shows the GPR horizontal depths slice sequence where several features (Fig. 5a) are clearly identifiable. The GPR vertical depth sections in Fig. 5b−c (Profiles A and B) show reflection patterns indicating the top part of crypts (A, B and C) at a depth of around 0.6m (10−12ns).

Due to the ambiguity in gravity field interpretation the geometry of the modelled crypts has to be verified by drilling or archaeological excavation. This case study highlights the benefits of a multidisciplinary approach to sense the present and past of our historical monuments and thus contribute to their documentation for future generations.

Geophysical results

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Archiving geophysical survey data from the Brú na Bóinne WHS, Co. Meath, Ireland

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The Brú na Bóinne World Heritage Site is known for its Neolithic passage tomb cemetery although much recent evidence indicates that many other low-visibility and subsurface monuments and sites also survive in this landscape. Numerous archaeological excavations have taken place and various remote sensing datasets exist for the area.

Introduction

Although a number of geophysical surveys have been conducted, many were piecemeal and site- or monument based and are not integrated with other forms of landscape data. The Brú na Bóinne WHS Research Framework advocates the construction of a Spatial Data Interface to store, connect and display current and future information relating to the WHS and make this accessible as a web-based database/interface. Legacy geophysical datasets must be properly archived and mapped to safeguard the resource and maximise their utility in planning future research campaigns.

A history of geophysical survey in the Brú na Bóinne WHS

The first geophysical survey in the area took place in the late 1980’s and the results were published promptly. Between then and 2013, upwards of 55 separate surveys have taken place using a variety of techniques (Fig. 1). The majority of surveys relate to research activity although some relate to development activity. Construction of the database is ongoing. Further work needs to be done on exact survey locations and extents, equipment used, methodologies, data processing etc.

Less than 30% of the surveys are either published or are available online and already it is clear that for some of the earlier surveys data compatibility and archiving issues mean that they will probably not be available for any assessment exercise (Fig. 2). This makes the current archiving project all the more important to salvage data from some of these older datasets.

The preliminary database

The Table and map show known geophysical surveys conducted to the end of 2013 (Fig. 1&2). It is based on published references, mentions in the www.archaeology.ie and the www.excavations.ie databases. Excavations.ie gives summary accounts of excavation activity on a year-by-year basis and also on conference presentations and personal communication. Extensive linear surveys were carried out to the west of the WHS for Meath County Council and the National Roads Authority along the route of the proposed N2 Slane Bypass and in 2006 there was another linear survey carried out along a line parallel to the M1 motorway at the eastern edge of the WHS.

The line of the M1 motorway was not geophysically investigated prior to excavations along the route in 2000/2001 (Fig. 3). A significant number of surveys were carried out as part of larger more recent studies; particularly the Lithic, Scatters and Geophysics project and the Boyne Valley Landscapes project.

Selection of surveys

Open source Quantum Geographical Information System (QGIS) is being used to map the catalogued ground geophysical surveys carried out in the WHS. The data are displayed on a raster image of airborne LiDAR data combined with a vector image of the digitised field boundaries (Fig. 4). Initial survey data input to the GIS include electromagnetics, total field and vertical gradient magnetics, magnetic susceptibility and earth resistance. Individual surveys on a field-by-field basis have been carried out using hand-carried instruments and simultaneous multi-method surveys have been carried out using a towed Geophysical Exploration Equipment Platform (GEEP) (Fig. 5). The final stage will be to input the linear ground surveys carried out as part of planning and construction of road developments. Future work will include the input of satellite multi-spectral and orthophoto images to the GIS as it is further developed to include all geophysical surveys carried out within the WHS.

Reference:
Discoveries through remote sensing: Investigating late prehistoric sites in Eastern Ireland

Ger Dowling / Rob Shaw
1. The Discovery Programme

Introduction

The Discovery Programme has recently completed a dedicated campaign of geophysical investigations as part of the ‘Late Iron Age and ‘Roman’ Ireland’ (LIARI) Project. The project sought, among other things, to shed light on settlement and society in Ireland during the first five centuries AD.

The four study areas chosen are shown on the map, which also highlights their close proximity to archaeological sites of known late prehistoric significance, as well as important natural features.

Locations

Building on a substantial body of research undertaken by the Discovery Programme in the Meath–north Dublin region since the early 1990s, the present investigations marked the beginning of a new phase of field work that targeted a selection of prominent hilltop sites suspected on the basis of archaeological, topographical and early documentary evidence to have been important focal centres in later prehistory. Despite the obvious archaeological potential of these sites, however, none had been subject to detailed investigation prior to the present study. The selection process utilised a range of remote sensing resources, online geospatial data, LiDAR derived terrain models and orthoimagery.

Results

The surveys have revealed a spectacular array of features, ranging from large-scale enclosures to numerous smaller features and structures (see below), with two of the target sites, namely Faughan Hill (Co. Meath) and Knockbrack (Co. Dublin), emerging as places of exceptional, if previously ill-understood, archaeological significance.

Faughan Hill

Faughan Hill (109m above sea-level) is identified in early documentary sources as the burial place of Niall of the Nine Hostages, eponymous ancestor of the Uí Néill federation of dynasties that came to dominate the kingship of Tara from the seventh to early eleventh centuries AD. Although nothing of archaeological potential is visible on the hill today, the array of features revealed by survey is astonishing and includes at least two massive hilltop enclosures, as well as a range of smaller, circular, features (ring-ditches and enclosures) on the summit. The most striking enclosure (about 440m in overall diameter) is defined by two widely-spaced boundaries, the outer example of which consists of two closely-spaced ditches, with traces of a possible palisade trench located inside the inner ditch. About 50m inside and concentric with the outer enclosure, the inner enclosure (c. 270m in diameter) is defined by a single ditch. The concentricity and similarly-aligned entrances (on the north-east) of the inner and outer enclosures suggest them to be contemporary, perhaps dating from the Late Bronze Age or Iron Age. Another, potentially earlier, hilltop enclosure was also identified inside the inner enclosure and is defined by a pair of closely-spaced lineations, possibly representing narrow ditches and/or slot-trenches, that extend in a broad, angular arc around the summit of the hill.

Knockbrack

The summit of Knockbrack (176m above sea-level) is the location of a significant concentration of archaeological remains, including at least six prehistoric burial mounds and the remains of a massive, possibly internally-ditched, enclosure. One of the burial mounds lies at the approximate centre of the hilltop enclosure, the significance of which was corroborated by geophysical survey. Although the outer bank of the enclosure is largely levelled today, the circuit of the enclosure ditch (2m to 5m in width) was mapped by survey, revealing it to have maximum dimensions of 355m east–west by 330m north–south. The monumental scale of the enclosure, together with its internally-ditched morphology, hilltop siting and central burial mound, suggests that it may represent an Iron Age ceremonial site, comparable to the first-century BC internally-ditched enclosure of Ráith na Ríg at Tara. Indeed, like the latter, the enclosure at Knockbrack is also distinguished by a significant concentration of internal features, including many small circular enclosures and ring-ditches, which collectively point to multi-period, ceremonial and funerary, activity, potentially spanning many centuries.

Archaeology students and graduate researchers from the National University of Ireland, Galway, and University College Dublin participated in the investigations. The student volunteers were trained in the fundamental stages of geophysical survey – from survey planning, data gathering through to data processing and interpretation, with the intention that on completion they would have gained the basic skill set to undertake such surveys on their own.
Exploring aerial archives and non invasive prehistoric settlement prospection in Lithuania

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Introduction

Within the “ArchaeoLandscapes Europe” project Klaipėda university chose three main objectives:

First objective – create a digital database of black-and-white archival aerial images, which are used for research and educational purposes. Thousands of archival aerial images dated from 1949 to 1980’s were scanned, mainly covering parts of the western region of Lithuania.

Second objective – the non invasive prospection of Iron Age hill forts and settlement complexes using geophysical techniques. In collaboration with the Roman Germanic Commission (Dr. Sebastian Messal) several archaeological sites were surveyed in both western and eastern parts of Lithuania. A certain number of building, fortification and burial sites were identified within archaeological complexes which were previously unknown (for results of the survey of Opstainis-Vilkyškiai Iron Age hill-fort/settlement complex see below).

Third objective – the organization of specialist workshops for students. The first workshop, mainly on the interpretation of archival black and white aerial photos, was held at Klaipėda University 27th - 31st August 2012. Another workshop, on geophysical field survey methods and interpretation of data, is planned for early April 2015.

Results of the geophysical survey of Opstainis-Vilkyškiai hill-fort/settlement-complex in 2010-2012

This hill-fort/settlement-complex is situated in western Lithuania. The fortification is built on the tongue of a hill on the left-hand bank of the Apsta rivulet. The outer settlement of the hill-fort is – according to surface finds, small-scale excavations and geomagnetic data – situated in two places. The so-called eastern settlement is situated east and northeast of the hillfort and covers an area of ca. 2.5 hectares. The other settlement, called northern, is situated north and northwest of the hillfort, covering an area of approximately 3 hectares.

Geomagnetic surveys have been conducted in Opstainis-Vilkyškiai since 2010. The hill-fort plateau and the outer settlement, east and northeast of the hill-fort, were surveyed in 2010 (5-channel-magnetometer) and 2011 (16-channel-magnetometer). The area covered was 320 m and long and 110 m wide in a field which is slightly rising from south towards north, with the hilltop located in the northwest of the field. In 2012 further larger areas of the upper settlement north of the hill-fort were surveyed; currently a total area of 3.9 ha has been investigated by geomagnetic surveys (Fig. 1).

Eastern settlement

It can be suggested that accumulations of anomalies may indicate suspected areas of anthropogenic impact, primarily settlement traces. This is especially true for the close-spaced anomalies in the southern part of the measured area which are located within, or close to, the known ‘black earth’ area of the settlement. They can be interpreted as archaeological features of various types that have already been confirmed by excavations of selected anomalies (semi-pit houses, storage pits; wells) (Fig. 2).

In the northernmost part of the survey a rectangular structure consisting of at least 20 small rounded and oval anomalies could be detected. The structure is about 19m long and 7-9m wide; the average distance between the single anomalies is about 1.8 and 2m. The interpretation of this structure remains open but the rectangular plot as well as the size of the structure may indicate the location of a post building (Fig. 3).

Northern settlement

The geomagnetic survey revealed a rectangular structure with dimensions of 6 x 4 m which may be interpreted – according to numerous analogies – as remains of a burnt building. Other accumulations of anomalies south and east of this structure may therefore indicate similar structures. A linear structure was detected in the north-eastern part of the plot and extends from north to south; the recorded length is 22.5m. This structure is also visible in the field and marks the current field boundary to the adjacent field track (Fig. 4).

Fig. 1: Opstainis-Vilkyškiai. Geomagnetic surveys 2010-2012 (5-/16-channel-magnetometer; -6/+6 nT). Graphics: S. Messal.

Fig. 2: Opstainis-Vilkyškiai. Geomagnetic survey; details of eastern settlement with probable semi-pit houses, storage pits; wells (5-/16-channel-magnetometer; -6/+6 nT). Graphics: S. Messal.

Fig. 3: Opstainis-Vilkyškiai. Geomagnetic survey; details of eastern settlement with probable location of a post building (5-/16-channel-magnetometer; -6/+6 nT). Graphics: S. Messal.

Fig. 4: Opstainis-Vilkyškiai. Geomagnetic survey; details of hill-fort plateau and northern settlement with probable ditch and burnt houses (5-/16-channel-magnetometer; -6/+6 nT). Graphics: S. Messal.
New remote sensing at the Dowth Estate, Brú na Bóinne WHS, Ireland

Stephen Davis / Knut Rassman / Hans-Ulrich Woss / Chris Carey / Christine Markussen / Lizzie Richley


Introduction

The Dowth Estate represents one of the largest land holdings within the Brú na Bóinne World Heritage Site, one of only two UNESCO WHS within Ireland (Fig. 1). It comprises over 20% of the core area of the WHS and is best known for its large henge monument known as Site Q or Dowth Henge. The estate is dominated by 18th Century plantation features, representing an exceptionally well-preserved planned landscape, with multiple ‘tree ring’ features, a deer park and an old race course. A range of other monuments, both prehistoric and medieval are recorded, including two passage tombs, a concentric enclosure and the site of a now destroyed stone circle.

Surveys using a variety of remote sensing methods have been ongoing at Dowth since 2010. Initially these used LiDAR data at 1 point per metre, and aerial images. Initial geomagnetic survey in 2012 concentrated on key monuments (e.g. Site Q) and on features previously identified through LiDAR data, resulting in the identification of the concentric enclosure previously mentioned. In 2013 the estate was acquired by Devenish Nutrition who commissioned a new FlimMap LiDAR survey at 40 points per metre with the joint aims of better defining the archaeology of the estate and estimating above ground carbon. This was also accompanied by new, large-scale geomagnetic prospection in collaboration with the RGK, Frankfurt, using both 16-sensor and 5-sensor geophysical rigs. Additional survey using a dual-sensor rig was undertaken in collaboration with Dr Chris Carey, University of Brighton resulting in a total coverage of c. 60 ha by the end of August 2014 (Fig. 3). Selected areas have also been surveyed using a combination of ERT and GPR. The scale and resolution of the data gathered has begun to revolutionise our understanding of this landscape and represents the largest, most detailed remote sensing survey to date within the WHS.

Remote sensing at Tlachtga

The new LiDAR survey represents a significant advance from the 1 point per metre data of 2007 (Fig. 2). It clarifies a number of demesne features which were impossible to see in the earlier data, such as the walled garden and pond features, as well as highlighting at least three very small or very low profile enclosure features. New agricultural landscapes are also revealed, in particular cultivation traces on the steep terrace slopes. Digitisation of features has been undertaken in a semi-automated fashion using contouring of the geomagnetic data (Fig. 4). This has resulted in large numbers of polygons giving a detailed picture of magnetic anomalies throughout the estate. Several areas have revealed exceptionally previously unidentified archaeological features, in particular the area between the henge and the demesne house (Dowth Hall) and the area of the concentric enclosure.

Palaeoenvironments and excavation

The area between Site Q and Dowth Hall represents what appears to be a previously unidentified complex of prehistoric features. These are dominated by a broadly-ditched circular enclosure, 45m in diameter which may represent a second henge monument. Further south of these is a complex collection of enclosures and pit-alignments, akin to other important ritual centres towards the end of the Neolithic in Ireland (e.g. Newgrange Pit Circle; Ballynahatty). This is associated with a ‘box-like’ entrance feature, also bearing closest similarity to Ballynahatty, Co. Down.

The area of the concentric enclosure includes at least three likely house structures, including one very large (c. 8m x 9m) rectangular structure in addition to at least one probable souterrain. A second enclosure, probably also early medieval in date was also discovered less than 100m NE of the known feature. Additionally elements of both co-axial field systems (Racecourse Field) and later medieval settlement (Glebe Field) were discovered. Additional survey is planned to further enhance our understanding of this important ritual landscape, with plans for limited excavation in summer 2015.
Owieczki: Constructing the archaeological landscape

The aim of this poster is to show how both archeologists and the local community construct the archaeological landscape and to discuss whether non-invasive methods can help in the interpretation of the past in this context. The problem will be presented based on the site in Owieczki, situated by the lake Owieczki in Wielkopolska Region, Poland (Fig. 3).

The village was first mentioned in historical sources in 1397.

History of the research of the site

The site was first recorded in 1912 when two questionnaires were filled in. Both described a mound – the first one was filled in by the landowner who described the site as a burial mound, the second one was done by the village administrator who did not define it.

Archaeologists ‘discovered’ the site for their study in the 1930s. W. Kowalenko published it in 1938 as an early medieval stronghold, based on information from a local teacher. The Regional Conservator of Monuments in Poznań described the site as a motte of great value for an early stage of Polish statehood.

In 1964 G. Mikołajczyk, archaeologist from Gniezno returned to the concept of the site as a burial mound associated with the open settlement (Fig. 1). This view was repeated in 1971. In contrast, two eminent archaeologists (W. Hensel and Z. Hilczer-Kurnatowska) published the site as a motte, and consequently the interpretation of the site as a burial mound disappeared from archaeological discourse. Their opinion was repeated in the recording of the site during a field-walking project in 1984. Surprisingly the value of the site was described as ‘medium’. In each publication the mound was described as 3-3.5 meters in height and 13-13.5 meters in diameter. In each description an old pear tree on the top of the mound was mentioned. Also the negative impact of ploughing was mentioned in each document and publication.

Local society discourse versus new research methods

Whilst scientists finally concluded that the site is a motte, the inhabitants of the village at the beginning of 20th century interpreted it as a burial mound. It was supposed to be a grave of officers, or soldiers, or Russians or Russian officers. An interpretation like that mentioned in both first questionnaires.

Due to migrations and changes of the local community and the discontinuity of the local traditional narrative, nobody remembered the meaning of that place. Currently local people do not have much interest in the site.

Actually, we still do not know what the site was in the past. Consequently, the area was a subject of several aerial surveys but no traces of past human activities were identified (neither traces of the mentioned settlement nor structures or a ditch related to the motte (Fig. 2). Geophysical prospection took place on November 19th, 2013. A Geometrics G858 Magmapper cesium magnetometer and RTK GPS were used for precise measurement of the site and vicinity.

Unfortunately, the mound itself could not be surveyed using the magnetometer due to the large inclination of the mound’s slopes and very thick shrubs. Based on ground survey, the size of the mound was about 15m in diameter and 3.5m height (Fig. 4). On the surveyed area some changes in the intensity of the magnetic field were observed but no data suggested the presence of stone or wooden structures surrounding the mound (Fig. 5). So far even geophysical methods could not give an answer about the function of this site.
Introduction

The Institute of Archaeology of the SAS in Nitra participates in the project through prospection of Žitný ostrov, the largest river island in Central Europe. Any changes made in the subsoil that are not filled with the original soil can be identified by aerial archaeology through vegetation and soil symptoms.

The reconstruction of the archaeolandscape of the studied territory can be divided into two separate subgroups - artificial and natural interventions. The artificial intervention means creation of an “ancient country” with an original river network and possibly also an “ancient” road network. This method of reconstruction is mainly done from perpendicular ortho images. The second method is the collection and analysis of relevant archaeological facts. For this option a set of activities such as aerial prospection, digital data processing, geophysical measurements with geodetic analysis and data collection are carried out at several sites in the studied territory.

Prospection

In the years 2010-2014, 14 flights were conducted. Over this period about 200 sites with vegetation and soil symptoms were recorded in the studied area. The following types of feature occurred most frequently: linear features, ditches, Roman marching camps, linear remains of extinct fortification systems, closed round features, closed rectangular features with rounded corners of different dimensions and settlement features. A significant part of the project is processing previous records and loading data through the program Arcgis into the geographic information system, in which the aerial prospection data create an independent information layer. The aerial archive built in 1987 contains about 7000 analog images in the form of monochrome negatives and diapositives and about 9500 images in digital form.