Geophysical Surveying Potential at the Veszto 20 Site

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Introduction

Over the past several decades, geophysical surveying of archaeological sites has become increasingly effective and useful for understanding the archaeological record. Geophysical surveying is the use of geophysics to remotely detect subsurface objects and features without direct contact or excavation. As the methods and instruments for geophysical survey are refined and costs reduced, these surveys should be integrated into all archaeological projects when possible.

Non-intrusive surveying techniques are important to archaeological projects, because they provide the ability to map and detect sites without destructive excavation. The extent of a site can be detected remotely, thereby avoiding the use of trenches and test pits for this purpose. In general, geophysical surveying is non-destructive, less expensive than excavation, capable of providing better spatial coverage, and fairly rapid compared to standard excavation (Vendl 2001).

Some aspects of geophysical survey still prohibit wide application of these techniques. Some problems encountered are shallow depth penetration ability of the instruments, interpretation of data can be difficult and results ambiguous, and instrumentation can be expensive (Vendl 2001).

At Veszto 20, the application of specific geophysical techniques could be extremely useful for determining the extent of the site, specifically of the wattle and daub structures. The following is a description of potential surveying techniques, a short summary of the Veszto 20 site, and recommendations for future geophysical surveying at the site.

Geophysical Survey Techniques

There are many different geophysical techniques available to the archaeologist, each with their own strengths and weaknesses. The techniques can be divided into the two broad categories; passive and active methods. Passive methods detect anomalies or changes in the Earth without introducing any energy. Passive methods include magnetometry and aerial photography. Active methods introduce some sort of energy into the ground and then detect subsurface responses. Active techniques include resistivity, electromagnetics and ground penetrating radar.

Magnetic Susceptibility and Magnetometry

Magnetic techniques are based upon the detection of magnetized iron oxides in the Earth (Bevan 1998). Distortions and anomalies of the Earth's magnetic field can be mapped using magnetic susceptibility and magnetometry.

Magnetic susceptibility (MS) surveys can measure the ability of a soil to become magnetized (English Heritage 1995). The MS of a soil is determined by the presence of iron oxides from the parent material and also by other chemical features of the soil. Human influence affects the MS of soil, usually resulting in higher magnetism, allowing MS survey to detect areas of human activity (Gaffney, Gater, and Ovenden 1991). There are several drawbacks to MS techniques, however. They can be very time consuming and frequently penetrate to depths of only 10cm (English Heritage 1995). Additionally, changes in MS can be caused by many different factors, and do not necessarily indicate past human activity (Gaffney et al. 1991). For this reason, English Heritage has recommended that MS should only be used in conjunction with other methods, such as magnetometry.

Magnetometry is a more popular and useful method of survey. Magnetometry measures changes in the Earth's magnetic field due to near surface physical or chemical changes (Conyers 1999). Materials, which have been heated to a specific temperature, the Curie Point, reset their magnetic orientation. As the material cools, it will acquire a new magnetic orientation according to its position, and can be detected by the magnetometer (Gaffney et al. 1991). Magnetometers can also detect changes in the magnetic field due to features such as soil disturbances, fired earth, and ferrous debris (Gaffney et al. 1991).

Electromagnetism

Electromagnetic (EM) surveys measure the response of soil to electromagnetic waves introduced by the instrument. Modern EM equipment can measure both the conductivity and MS of the soil (Gaffney et al. 1991). EM is capable of detecting earthen features and lateral changes in soil geology, but it is best used on conductive soils for good resolution (Vendl 2001). EM has not been used extensively enough for archaeological sites and requires more experimentation (English Heritage 1995).

Resistivity

Resistivity surveys are one of the simplest and most popular geophysical methods. This technique measures the ability of the soil to resist an electrical current. Differences in resistance can be due to the nature of the soil, water content, and porosity of material (Vendl 2001). Human activity often alters the geology of a site or introduces features, which can be detected by resistivity survey (Gaffney et al. 1991). Some targets of resistivity survey include walls, roads, pits, and graves (Gaffney et al. 1991). Although resistivity is simple and inexpensive, it can be a very time consuming method of survey.

Ground Penetrating Radar

A favored geophysical technique is ground penetrating radar (GPR). The primary reason for its popularity is the ability to produce a three-dimensional image of the subsurface (Gaffney et al. 1991). GPR works by introducing radar waves into the ground and then measuring the travel times of the reflected waves (Vendl 2001). GPR is capable of providing high resolution images of burials, voids, and structures (Vendl 2001).

Self Potential

The self potential (SP) technique measures near surface voltage created by ionized ground water (Bevan 1998). This method has not been used extensively in archaeology and is still considered experimental (Bevan 1998).

Seismic

Seismic surveys introduce seismic waves into the ground and then measure the travel times of reflected waves (Gaffney et al. 1991). This method has mainly been used to detect larger anomalies such as tombs. Seismic surveys can be difficult to carry out, because it is necessary to eliminate all background sources of seismic waves, including people walking at the site.

The Veszto 20 Site

The Veszto 20 site is an Early Copper Age settlement with large amounts of Tiszapolgar ceramics, located on the border of Veszto, Hungary (Parkinson 1999). The site was resurveyed in 1997 and test pits were dug in the summer of 2000. During the summer of 2001, two large blocks were opened for excavation of potential wattle and daub structures. The site is situated on top of a small rise with silty clay loam soil. Survey and excavation have yielded high concentrations of ceramics, daub, animal bones, several human remains, and a midden. The daub is likely the remains of at least two structures at the site, whose spatial extent are still being determined. This site is one of the first Early Copper Age settlement sites to be excavated, and will provide much needed information about this poorly know subject.

The most likely targets for geophysical survey will be the subsurface daub concentrations. Accurate detection of these daub concentrations would likely provide a map of the walls of structures and the extent of the settlement. Other targets would include potential kilns, storage pits, and burials at the site. Thus far, kilns and storage pits have not been identified. At least one burial is present, but it intrudes the site from the $8^{th}/9^{th}$ century, and is not associated with the Early Copper Age settlement. Geophysical surveying could potentially detect other disturbances of this type.

Geophysical Survey Recommendations

Given the site conditions and targets of investigation, the choice of a geophysical surveying method should bear several factors in mind. First, the technique must be suited to detecting the necessary targets at the site, particularly daub concentrations and pit features. Second, the technique must be appropriate for the conditions of the site, especially the soils and ground surface.

Magnetic susceptibility survey would be appropriate for detecting changes in lateral geology at the site, as well as defining activity areas. However, activity areas are not a target of investigation at this site, especially since it is unclear whether such areas exist or could be detected. Magnetic susceptibility would be a poor method of investigation at the site for reasons of ground cover. MS is most effective on flat surfaces devoid of vegetation. The uneven and vegetated surface at Veszto 20 is not ideal for MS survey and could provide erroneous readings.

Additionally, iron objects, such as those found in the Middle Ages grave, would affect the readings.

Magnetometer survey would be the best geophysical method for this site. Magnetometery is perfectly suited to detecting burned features, such as the daub concentrations at Veszto 20. It is also capable to detecting some pits and hearth features. There are very few field factors that would affect the magnetometer, such as power lines, pipes, and fencing. Ground conditions at the site would not be a problem for the survey either. Under ideal conditions, there will be a strong magnetic contrast between the topsoil and the subsoil at the site. Whether this is true at Veszto 20 or not is unknown.

Electromagnetics would be a poor choice for geophysical survey method at this site. EM is most suited to detecting soil changes and earthen features. Neither of these are main targets at Veszto 20. However, there is no reason to believe that an EM survey would not work at this site, so it may remain a possibility in the future.

Resistivity survey may not be the best method for searching for the targets at Veszto 20. The daub at the site is made of the same soil as the matrix, and this may provide erroneous resistivity readings, thus rendering the daub structures invisible to the survey. Another concern with resistivity is that it must be conducted at an appropriate time of year. Resistivity is sensitive to ground moisture and requires good contact with the soil to function properly. During the summer months, the ground at the site is too baked and hard to provide good contact with the probes, and the lack of moisture may provide anomalous readings. If resistivity survey is conducted, it would best be used to complement another method of geophysical survey, such as magnetometry.

Ground penetrating radar, although an attractive option for visualizing the site, may have difficulty penetrating the clayey soils at Veszto 20. The burned daub at the site is not an ideal target for GPR, although it could be a beneficial method for locating burials and large pit features.

Both self potential and seismic surveys are probably not the best methods to utilize as first choices for this site. These methods are often difficult to carry out and not generally regarded as the best methods for archaeological sites. These methods should only be used when there are special circumstances or targets that these methods are specifically suited for.

In summary, magnetometry seems to be the best method for investigating the Veszto 20 site. This geophysical technique is well respected in archaeology and has the capability of detecting daub structures much more accurately than any of the other geophysical methods. Strong support for the use of this method comes from surveys conducted by McPherron and Ralph in Yugoslavia (1970). Neolithic house structures made of straw and earth that had been burned were successfully detected by magnetometer survey, allowing a map of the site to be produced fairly easily (McPherron and Ralph 1970). The Veszto 20 site is different only in that there are no burned floors to the structures, which were present in the Yugoslavian survey. This should not cause a significant problem since burned earth is still present at Veszto 20, just not in the form of rectangular floors.

If more than one type of geophysical survey technique is used, resistivity may be a good second choice. Resistivity could produce data that complements the magnetometer survey by mapping changes in soil geology. However, it must be cautioned that resistivity may not be successful at the site.

Resistivity Survey at the Korosladany 14 Site

On July 12, 2001, Daniel Hammer and Karen Royce conducted a simple resistivity survey at the Korosladany 14 site. This site is a small settlement across the canal from Veszto 20, which dates to the same time period. The site was chosen to test the potential of resistivity survey at Veszto 20, since both sites have the same soils and similar features. Probes were sunk along the north wall of a test pit at the site, where a daub concentration was visible running along this wall approximately 30cm deep. The Wenner array configuration (see Bevan 1998) was used to make sounding readings along the wall. Four probes were used to take nine soundings at 20cm intervals. Readings were taken with the probes spaced 10cm, 20cm, 30cm, 40cm, and 50cm from each other. The data recorded were then used to produce maps of both vertical and lateral readings along the test pit wall.

The vertical soundings data were not interpreted in the field. The complex data are possibly erroneous, but could also be accurate data requiring more sophisticated processing and interpretation. The lateral resistivity data failed to produce any clear pattern indicating the presence or absence of daub in the wall. Resistivity was both high and low for daub, indicating that the survey was not successful.

One possible reason the resistivity survey was unsuccessful is the soil condition at the time of the survey. The soil had been baked by the summer heat and was very hard with large cracks running through it. This not only made the probes difficult to insert into the ground, but the cracks could have allowed poor soil-probe contact. Bevan recommends pouring water around the probes to soften the soil (1998), but this was not done. Future resistivity surveys might be more successful if conducted in the spring or fall when the soil is less baked, but not saturated.

Conclusion

Many different geophysical survey methods are available to the archaeologist. These survey methods can be invaluable aids for excavations, such as Veszto 20, where they can ascertain the spatial extent of a site and the location of features, without digging test pits throughout the site. The geophysical survey method that would be most useful at Veszto 20 is magnetometry. This technique is ideal for locating burned earth features, like the daub structures at the site. It can also find other pit features and disturbances, which may exist. In light of the $8^{th}/9^{th}$ century burial at the site, magnetometry could also help find other similar disturbances. A fluxgate gradiometer is the most modern and useful type of magnetometry instrument available (English Heritage 1995), and it is recommended for this site. Magnetometry has been successful at detecting similar features in Yugoslavia (McPherron and Ralph 1970), and there is no reason to believe that it would not work at Veszto 20.

A test of resistivity at a nearby site, with a similar feature as a target, was unsuccessful, but may work in the future. Resistivity conducted under ideal conditions may produce better results. However, this method is not recommended, and should be used only if readily and inexpensively available. Veszto 20 is an important site for defining Early Copper Age settlements. It would be beneficial to use all techniques available, including geophysical survey, to shed light on this poorly known time period.

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