Archaeological Prospection

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1. Introduction

"Archaeological prospection" generally refers to non-destructive identification of features and relics buried at archaeological sites. Archaeologists are also beginning to think of archaeological prospection as referring to discovery of cultural assets from materials like wood or stone that are already recovered from the ground and analyzed for their chemical histories.

Chemical prospection has actually been employed much longer than geophysical prospection in archaeology. Chemical prospection in Europe dates back to the 1920s. The most widely practiced method in archaeological prospection is identification of ancient occupation from interpretation of aerial photographs. This method was initiated in the middle of the 19th century, when archaeologists discovered that the existence of underground remains could be determined by the effect that subsurface remains have on the immediate ground surface. O.G.S. Crawford, who systematized this method primarily in the 1920s, contributed largely to the popularization of photograph interpretation.

Resistivity began being used immediately after World War II, followed by magnetic survey and ground-penetrating radar, or GPR. Other methods such as electromagnetic method, or EM, as well as seismic surveying have recently been applied.

1-1 Fundamentals of prospection

Archaeological prospection is fundamentally concerned with the identification of contrasts between materials inside and outside of archaeological structures. If there are underground remains, these can have an affect on the surface of the ground which can cause variations in ground dryness and vegetation growth. If one compares with soils outside of the buried features with those inside or contained within the feature, differences in electric resistance, electrical conductivity, dielectric permittivity as well as magnetic susceptibility can exist. By measuring these physical changes in electromagnetic properties across buried features, there is a possibility of detecting subsurface remains.

If the differences in the physical constants of soils are considerable, remote sensing by prospection will be easily facilitated. It is nonetheless difficult to discover deeply buried remains regardless of the degree that targets features are contrasted with surround materials. In these instances it becomes necessary to detect very faint signals when searching for deeper structures, regardless of the geophysical method being employed. Signals from deeper targets contain information from surrounding

soils, which also makes it difficult to discover smaller targets within the geophysical dataset. Smaller targets which are buried shallowly however, can in general be detected.

At some archaeological sites there is often no significant difference in soils inside and outside features like postholes, making these kinds of targets impossible to detect. Generally speaking, these archaeological features are also difficult to identify by archaeologists even after "destructive" excavation.

Prospecting for archaeological sites is different than prospecting for hot springs, underground water or for veins of ore. Archaeological sites are generally "localized" and rarely have significant vertical or horizontal dimensions in the ground. Prospecting therefore requires data collection at very fine intervals in order to discover archaeological sites.

With the exception of special cases, targets in archaeological prospection studies rarely exceed the depth of 5 meters. With ordinary ground probing, this depth is within the range of surface noise. Measurement methods and data analysis software for probing deep strata are therefore not suitable for detailed analysis of structures positioned at shallow depths.

Because of these differences, the expected results may not materialize right away if common methods, without some modification of probing the ground, are used for site prospection. Keeping these points in mind, engineers and prospectors that embark on archaeological prospection using modern technology must familiarize themselves with the unique conditions for archaeological prospection in order to have any measurable success with their surveys.

1-2 Objective of prospection

1) Preliminary information prior to excavation

The majority of archaeological site prospection is conducted for the purpose of collecting information about what is below the ground prior to excavation. This may be one of the most useful aspects of applying remote sensing.

Why is this? The objective for archaeological site surveys and excavation research is to collect historical information from archaeological sites, structures and relics buried in the ground by digging. If the condition of what is below the ground can be determined prior to digging, an excavation plan can be suitably formulated and large quantities of accurate information can be collected. This can both save time and money in understanding and discovering a site.

Excavation by definition involves digging and moving earth. Once earth is removed, it can't be returned to its original state. In other words, digging cannot be done over again. This is an inherent feature of excavation – it is a destructive invasion into the ground which is not reversible. Excavation is consequently an extremely specialized

and important job that cannot be repeated twice at a site if mistakes are made. If you can determine the condition under the ground, in other words, discover its position, shape and depth of the buried materials before digging is initiated, it will enable you to excavate a site without error.

Prospection of archaeological sites however cannot always offer sufficient information about what is under the ground. In some cases it can do no more than indicate the general range of soil variation. Nonetheless, blind test pit excavations at some regular intervals are often not able to yield any reliable information on a site either. Using test pits or trench excavations that are chosen from examination of geophysical anomaly maps, can be used in formulating a more comprehensive understanding of a site when used in conjunction with prospection.

Most archaeological prospection involves non-destructive methods. With the exception of chemical prospection that requires analysis of relics and soil samples, prospection conducted from above ground, basically does not alter the surface of the ground. The most intrusive of all geophysical methods, resistivity, only calls for inserting a thin iron rod about 1 cm in diameter about 10 cm into the ground.

The objective of archaeological site surveys is to collect historical information about buried artifacts. We must therefore try to gather as much information as possible using the various scientific methods currently at our disposal before initiating digging. Research involving restoration of old environments such as analyzing the quality of excavated soil or relics is one example of an attempt to expand the collection of historical information. Similarly, if archaeological site prospection is understood from this perspective, there is no question as to the importance as well as our responsibility in employing prospection prior to excavation.

2) Archaeological site preservation

If there is a need to take measures to preserve an archaeological site after finding out about its contents from excavating, it can not be known if the site has been irrevocably destroyed by removing dirt from an excavation. The possibility of understanding the complete story of the site can only be investigated if the site remains intact.

In cases such as this, it is possible to obtain the pertinent information needed for preservation using a non-destructive method of prospection. Many features that are obtained from excavation can also be detected remotely through prospection. Prospection is most useful for helping archaeologist extrapolate what is known about a site into unexcavated areas. For example, if one is trying to extend the location of a ditch from an excavated area into an unexcavated area, prospection can be adequately employed in tracing the ditch. Prospection surveys in similar kinds of applications have a high probability of success.

In the case of preserving archaeological sites designated as historical sites, it is first necessary to secure the area and determine its boundaries. Discovering the boundaries circumscribed by a site such as mapping a channel or rampart that may surround a settlement, is a relatively easy task that prospection can be used for. If the target is large, it can normally be identified even if it is buried deep in the ground. In the case of discovering channels or ditches, if these buried structures are also saturated with water, electromagnetic contrasts are even higher than if the structures were dry, making for easy identification from geophysical remote sensing.
Many targets associated with settlements are often difficult to identify though. Small postholes are especially difficult and often remained insufficiently detected on most surveys. However, even if the individual postholes remain unmapped on the survey data, settlement floors and boundaries are still often discovered because of variations in materials or soil compaction measured within and outside of the settlements. Test trenching over suspected remains mapped from the survey data can help to calibrate datasets for a site and aid in determining the distribution of occupation of a site. Boring can also be used in these cases to minimize the site destruction as well.

3) Non-destructive prospecting

Exploring a site by destructive means, such as invasive excavation, often does not reveal the historical information from a site that archaeologists are trying to determine. In the case where a large burial mound has already been designated a historic site, various measures such as preservation and landscaping have already been initiated. These particular burials are already usually unavailable for archaeologists to probe with destructive excavation. When requests for studying protected burial mounds of the tumulus period are received, such as those that come in from academic institutions, the only available means to study these mounds are with remote prospection methods. Burial structures such as those found in Japanese tumuli, include unique features such as vertical chambers, clay coatings over wooden coffins, and various stone chambers which have extended corridors and entrances. Many of these features of interest can be imaged from prospection surveys. These essential features of the mounds can help archaeologists to better understand the historical value of the tumuli remotely – without employing destructive excavation.

Sometimes prospection is conducted by a single geophysical method and sometimes with little success in detecting the subsurface targets of interest. Because prospection is a non-destructive method, it is also possible to reoccupy the site again and use a different geophysical tool for probing which may be more effective. Prospection differs from excavation in that you can keep choosing another method over and over till you get the necessary information, whereas excavation can only be conducted once. It is empirically known that results may differ according to hygroscopic conditions and vegetation coverage of a site even if the same prospection method is being used. The possibility of also returning to a site during different seasons can sometimes also help to decipher the subsurface structures present.

As has been previously stated, there is a limit to the effectiveness for prospection, but it can nonetheless provide the necessary information concerning a variety of underground structures that archaeologists are after. If prospection is to be employed in the study of a site, it is necessary to properly set the objective of the prospection and use the prospection tool that best matches the objective. It is also often required to employ multiple geophysical methods in order to properly meet the survey objective.

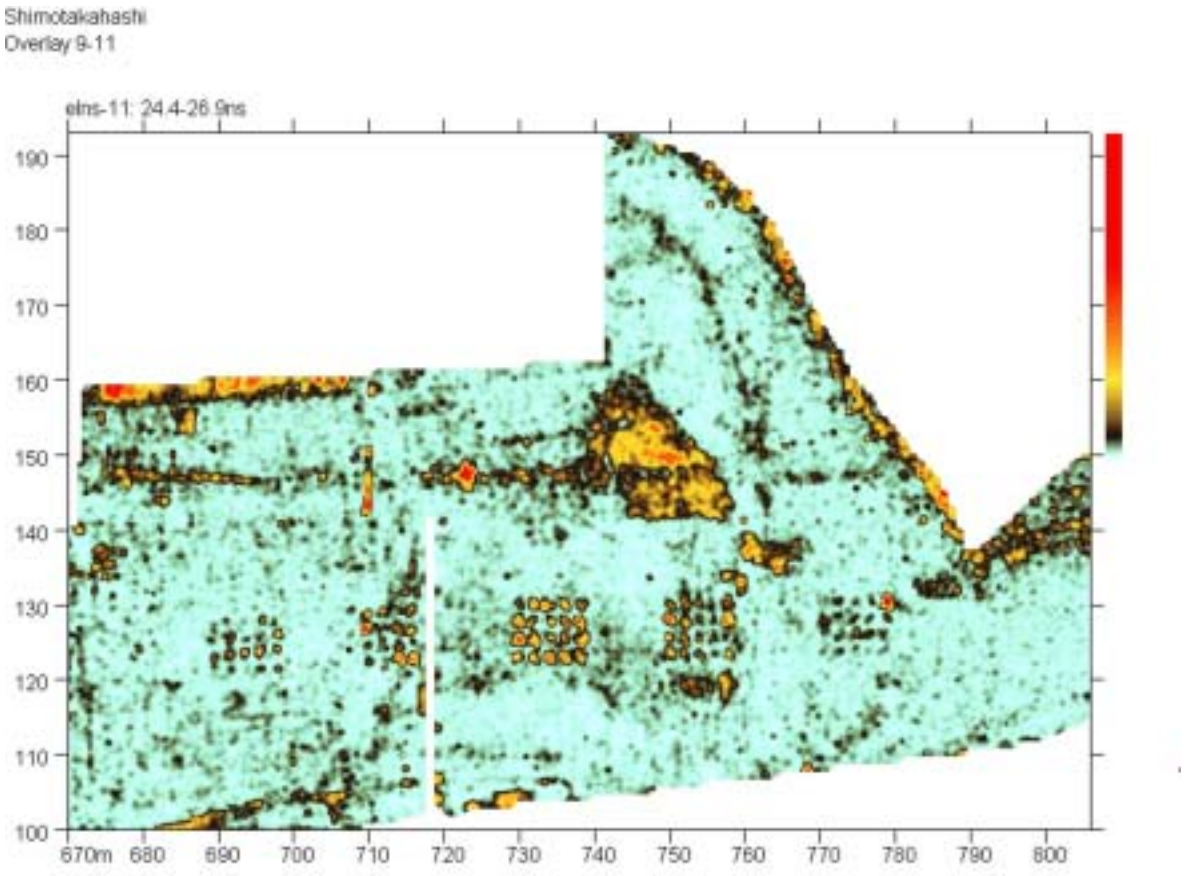
Each respective method of prospection helps determine “foreign objects” buried within the soil based on measuring contrasting physical factors with surrounding soils. Consequently, if the results obtained by different methods are classified and reported, these methods can be known through experience to be reliable or unreliable prospection methods for detecting targets buried in specific subsurface ground soils. The various geophysical methods available all relay separate and distinct information about subsurface targets. It often is the case that information obtained from one method is insufficient for interpretation, whereas another method may help the archaeologist discover the buried past.

Photo-interpretation

Keyhole shaped and round tumuli can be seen as soil mark

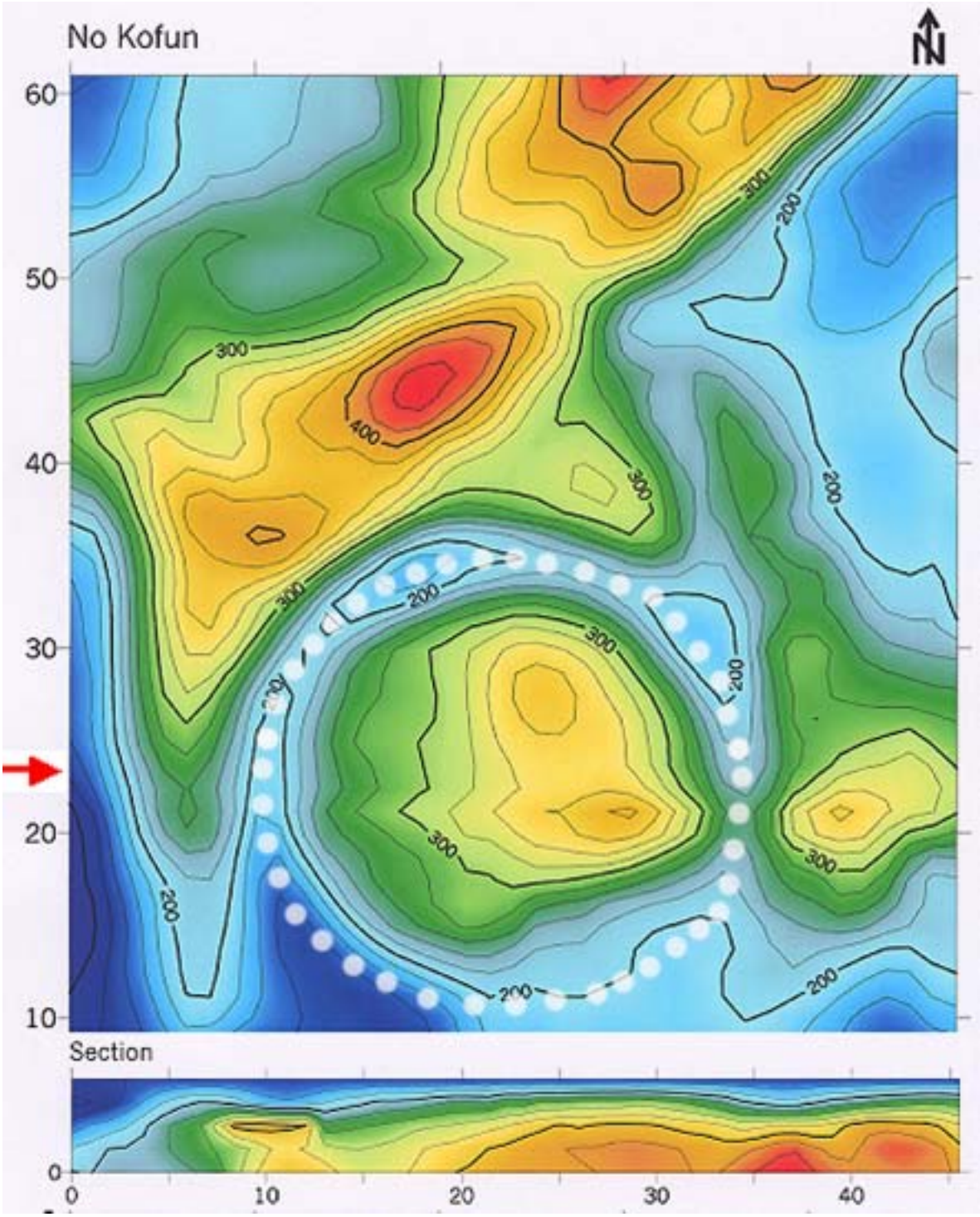
Magnetometer survey
FM18 fluxgate magnetometer

Ground Penetrating Radar Survey (GPR)
300MHz antenna



GPR survey result

Five storehouses consisting of 20 postholes can be seen as microwave reflection anomalies



Resistivity Survey

Round shaped tomb with surrounding moat can be seen as soil resistance differences