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Editorial

# The Place of Geophysical Studies in Archaeological and Anthropological Research

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## Introduction

Geophysical methods have been used as facilitator and guide in archaeological sites since the 1940s. The long and patient excavation process of archaeological research results much faster with geophysical methods and gives archaeologists the opportunity to gain time to apply their experiences to new areas. Considering that the expenditures made for excavations in archaeological sites are usually carried out with a limited budget, it is obvious how important it is to carry out accurate and result-oriented excavations. Considering that the expenditures made for excavations in archaeological sites are usually carried out with a limited budget, it is very important to carry out accurate and result-oriented excavations. The main reason for the success of geophysical methods in archaeological areas is the shallow depth of research. As the depth increases, the discrimination of small objects becomes more difficult. However, since it is sufficient to obtain information about the first few meters in archaeological areas, very successful results can be obtained with almost all geophysical methods. On the other hand, the excavation areas determined due to the nature of the archaeological studies are excavated in a very short time, allowing the rapid truthing of geophysical findings. Buried objects and features can be easily visualized on the surface with geophysical data before an excavation plan is created.

This optimizes the research strategy. As the excavation plans based on geophysical findings are carried out step by step, it becomes easier to identify the findings and to identify similar findings in later investigation areas. The richness of buried objects or structures in archaeological sites also creates positive effects on geophysical findings. The more advanced the civilization, the higher the signal quality of geophysical data and the level of distinguishable findings. Since the simple shelters created due to different climatic conditions except caves in ancient times were built with almost no construction technique, they were easily destroyed due to meteorological conditions and earthquakes. For this reason, it becomes almost impossible to come across any findings belonging to this period in geophysical studies, and it is perceived as if nature has never changed in the area where they are located. However, as the construction technique improves, cultural infrastructure elements for urbanization such as the use of fired bricks, the design of foundations, roads and water channels can be easily distinguished from natural soil conditions. The success of geophysical methods in applications in archaeological sites has increased in recent years. The main reason here is the increased sensitivity of geophysical devices and equipment.

## Application of Geophysical Methods

Geophysical methods came to the fore in the early 1900s in order to reduce the exploration costs in oil exploration and to increase the hit rate by reducing the number of long and extremely costly drillings, which were tried to be developed in order to examine larger areas in a faster way. Geophysical studies, which were first applied to measure the self-potential of the ground, are carried out with very high technological applications and various methods today. Of course, at the beginning of the level increase comes the developments in the computer and electronics industry. As a researcher who has been making geophysical applications in archaeological sites for nearly 30 years, I have the chance to compare the developments and application facilities. For example, the magnetometer used for the magnetic method in 1994 was a proton magnetometer with a resolution of 0.1 nT, as part of the pre-excavation site survey in the Harmanören Necropolis, the third largest excavated necropolis of southwestern Anatolia, dating to 2500 BC. However, due to the fact that the pithos uncovered during the excavations were large enough to enter a human body and underwent a thermal process such as the sun or an oven, they caused a strong magnetic anomaly, and it was possible to determine their location with such a magnetometer [1]. Nearly 10 years later, a high-resolution magnetic survey was carried out in the Dedemezari Necropolis, which is located near Afyon in western Turkey and is thought to belong to the Middle Bronze Age, using a magnetometer with a sensitivity of 0.01 nT and a caesium vapor. The shapes of the buried tombs were predominantly cylindrical and oval. Most of the magnetic anomalies were elliptical and reflected the shape of embedded materials [2,3].

Therefore, in parallel with the increase in sensitivity in geophysical instruments, the shape discrimination of buried objects has also been improved. The fact that the increase in sensitivity has been noticed so much in the intervening 10 years has naturally also positively affected the success in the results achieved. Another feature that makes it easier to distinguish in archaeological areas is that the building material used is brought from other areas. Mostly, sacred buildings, administration buildings, tombs of rulers were built with building stones that were considered valuable at that time. In this case, distinguishing these areas from other buried buildings is not only due to their dimensions, but also to their building material properties. Volcanic origin rocks such as granite and basalt, which are mostly accepted as valuable building materials, can be easily distinguished. According to Ekinci et al. [4], the ancient city settlement of Amorium, which was an important city in the Byzantine period and dates back to the Early Bronze Age, located approximately 170 km southwest of Ankara and east of Phrygia, was investigated by geophysical methods, including the city layers and the city remains were identified. In addition, it is more difficult to identify the remains of the buildings made with the local rocks in the study area. Discrimination in such areas is possible by detecting the presence of anthropological effects such as quarries, dug and closed pits, metalworking. Differentiation of the existing building remains in Divriği Castle in inner east Anatolia, which is an approximately 2000-year-old settlement, was quite difficult since different building materials were not used, however, magnetic anomalies could be defined based on edge effects, especially since a geometric order was created [5].

Geophysical measurements in archaeological sites are not sufficient on their own without specific data processing applications such as spectral analysis, filtering, transformation, derivation, analytical continuation. Mostly the measurements taken contain superficial noises and are affected by the earth's natural magnetic and electric fields. Therefore, after the data processing, archaeological objects, structures, etc. can be distinguished. Not only location detection, but also depth information can be created after detailed evaluations [4,6]. Many researchers working on this subject are trying to achieve much more advanced discrimination level by applying new data processing techniques in archaeological areas. Today, there are many studies on imaging with virtual excavation without digging [2,3,7,8]. The determination of organic residues by geophysical methods is quite difficult. Currently, there is no method that makes it possible to directly determine the buried human body or just the skeleton. However, with the excavation made during the burial of the body and then re-sealing it by placing it inside the body, the soil differs according to its surroundings. Today, the bodies of murder victims buried secretly are found using geophysical methods within the scope of criminological research. Similarly, tombs whose places have been forgotten over time due to irregular burials carried out in wars are being researched. Ground penetrating radar (GPR) has been adopted as the basic research method in anthropological research to find the human body. Many soldiers lost their lives in the bloody wars between 1915 and 1922 in Turkey, and the places where they were buried are approximately known. In 1915 Çanakkale land wars, approximately 250,000 soldiers lost their lives. The burial places of soldiers who died in the war were researched intensively on the Gallipoli Peninsula using different geophysical methods, primarily the GPR method Between 2011 and 2013 [9]. The burial sites of thousands of soldiers who lost their lives during the Battle of Sakarya and the Battle of the Commander-in-Chief, which is called the Turkish War of Independence between 1920-1922, were also investigated for the remains of GPR and war materials by magnetic methods [10]. An estimated 500,000 people died during the Spanish Civil War between 1936 and 1939. But there are more than 2000 known mass grave sites in Spain, and many more are unknown. In the study by Fernandez-Alvarez et al. [11], an unnamed mass grave was successfully identified by the GPR method in a mountainous terrain in the Asturias region of northern Spain.

The research of war materials also makes important contributions to historical and archaeological evaluations. Finding a simple arrowhead, identifying metals such as armour and horseshoes, as well as cannon and unexploded bomb locations are also possible by geophysical methods. Before the 1915 Dardanelles naval war, the cannons deployed for protection in Kumkale (Turkey), on the shore of the Dardanelles, were destroyed by the French. Over time, the buried remains became invisible from the surface. The locations of the buried cannons were determined with the magnetic research, and they were excavated and unearthed [12]. The effects of different burial traditions in archaeological sites are also reflected in geophysical data. The presence of burial gifts together with the dead body provides important contributions to geophysical anomalies. On the other hand, the construction technique, rock tomb, pithos, burial chamber, etc. methods used in the tomb are observed with different effects in geophysical data [13]. In addition to these, traces of cremation and traces of fire layers in the mounds can be easily detected by geophysical methods.

## Conclusions

Archaeological and anthropological excavations initiated based on geophysical findings provide a holistic view and planning of the excavation site. Findings obtained after geophysical studies give the opportunity to look at the archaeological problem as trying to verify whether the pieces of the puzzle are in the place where they were told, rather than trying to put the pieces of the puzzle together. Thanks to geophysical studies, which save time and money, more resources can be transferred to archaeological excavations.

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