Efficiency of Integrated Geophysical Techniques in Exploration of the Jurash Archaeological Site, South Saudi Arabia

Yasir Almutairi and Muteb Almutair
King Abdulaziz City for Science and Technology

KEYWORDS: Archaeology; Magnetics; Electromagnetic; Jurash.

ABSTRACT

This study is display the Geophysical surveys that were conducted at Jurash Archaeological site in Asir Area South Saudi Arabia. A geophysical survey that involved two different techniques of magnetic and electromagnetic (Metal detector), to get enhanced results while keeping quality control, the data points of gradient magnetic data of the surveyed area were processed using two processing software. The magnetic response of different sources usually varies from high to low values depending on the magnetic susceptibility of geological host materials and the depth of the hidden targets within the surveyed areas. The magnetic gradient method has a good response that appears as various anomalies corresponding to the medium changes in the subsurface target. Such anomalies were interpreted in the study are as probable archaeological features that may indicate the existence of archaeological findings such as boundaries between burial rooms or walls, buried walls, and damaged or discontinued walls.

Like other geophysical surveys; especially those related to archeological applications, the interpreted results should be augmented by other investigation methods or tests in the study area such electromagnetic method and/or archeological excavation to complete and ensure the subsurface image.

1.0. INTRODUCTION

The surveys were done over Grid that located in the north part of the site; depending on the Archeologist recommendations.

Geophysical studies have been widely used since the last decade in many archaeological sites around the world (Tsokas et al., 1994; Gaffney et al., 2000; Dabas et al., 2000; Mahmut G. Drahor., 2006). The aim of such studies is to help archaeologists for fast and effective excavations by providing the probable architecture of the settlement and locations of buried archaeological objects. Magnetic method is commonly used in archaeological exploration to detect features such as buried walls and structures, bricks, kilns, ditches, pottery, pits, buried pathways, and tombs (C. Gaffney., 2008; M. Leopold, et al., 2010; S. Y. Moussavi Alashloo, et al., 2011)

In Vertical Magnetic Gradient We have been used the fluxgate gradiometer, which is quite practicable, is a very important development to collect data quickly in archaeological prospection, this technique is extensively used to obtain maximum information from a site for subsurface planning (Walker and Somers., 1994; Clark., 1996; Mahmut G. Drahor., 2006).

2.0. Data Acquisition

The Geophysical data were acquired in these initial Geophysical surveys using Vertical magnetic gradient method and Electromagnetic (Metal detector) method. Has been used to design the study area fits the nature of the area. The corners of each grid were layout using the Differential Global Position system (DGPS) with accuracy in mm. All coordinates are based on the Base Station (Figure (1)) at point: 18° 12' 09.52593" N, 42° 49' 24.66215" E and Elevation 2057.309 m. Area 8 design work was appropriate survey to include the required targets, where the space (10 m by 10 m).

The study area was investigated using FM36 Fluxgate Gradiometer of the Geoscan Research Corporation. The recorded earth's magnetic field was slightly disturbed by some what is believed to be related to archaeological anomalies such as fired clay pottery. The magnetic signals associated with such archaeological features are typically very small and can be easily obscured by other objects such as trash metals, power lines, nearby automobiles, .. etc.
Magnetometers are usually very successful and best suited for remote isolated sites located away from modern buildings and slope debris. Modern magnetometers are sensitive to minute field changes of about 1 gamma in a background earth's magnetic field intensity of 50,000 gamma. Magneto meters has been successfully applied to locate imported stone at some well-known archaeological sites. Fired mud brick has a reasonably high magnetic anomaly and obviously ferrous materials such as one might expect at an Iron-age, that typically give rise to very large magnetic anomalies. In magnetic survey were served 21 parallels Profiles, Lengths are 10m, interval spacing are 0.5m; North direction. Gradient Magnetic measurements, interval spacing of readings are 0.5m.

EM61 MK2 Metal detector instrument from Geonics Limited is applied in the present survey. The EM61 metal detector utilizes time-domain electromagnetic phenomena to locate shallowly buried metallic objects (e.g. UXO) at a maximum depth range of 5 cm to 4 m. The system comprises three square coils of 1 m side. Coincident horizontal transmitter (T) and receiver (R) coils are mounted 40cm beneath a second horizontal receiver coil. The system is either carried or trolley mounted, at a constant height of 45cm above the ground. The EM61 is capable of detecting a single 55 gallon steel drum at 3m burial depth and offers better multiple target discrimination within the depth range than contemporary techniques such as magnetometers. The instrument also exhibits high cultural noise rejection, enabling surveying in regions crossed by fences, power lines, ....... etc.

In the electromagnetic survey were served 11 parallels Profiles, Lengths are 10m, interval spacing are 1; to North. Electromagnetic (Metal detector) measurements, interval spacing of readings are 0.5m.

Figure (1): The Base Station of DGPS system. All corner's coordinates

of each grid were layout using this base station at point: 18°12' 09.52593" N, 42°49' 24.66215" E, Elevation 2057.309m.

3.0. Data Processing
3.1. Magnetic Data Processing

Once the data is collected and composed in one mesh, some basic filters will be applied to the data in order to merge the grids and remove the grid borders between them. In general, we used the function of Zero Mean Grid (ZMG) to remove the grid edge discontinuities, the function of Zero Mean Traverse (ZMT) to remove the stripping effect, the function of the DeSpike (K) to remove the iron spikes, the function of the Low Pass Filter (L) to smooth and enhance the deep features, and finally the function of Clip (C) to improve the graphical presentation.

Additionally, other filters will be applied to the data in order to remove the noise in the field.

This noise could be due to iron or metal objects on the surface or even buried beneath the surface and cannot be realized. When the data is exported as XYZ file, it will be interpolated and will be as 0.25m interval which means that, it will be doubled. After these filters, the data will be ready for interpretation. It should be noted that, the FM36 Fluxgate magnetometer did not display the readings from during the 3rd grid but still beep which means that it does work.

3.2. Electromagnetic Data Processing

After downloading the data from the data storage unit were imported to DAT61MK2 to create data in Geosoft software in XYZ file. After that we show row data and We started in Mapping Process And use some filters To improve the quality of the data. Accordingly display the final maps.

4.0. Results and Interpretation
4.1. Magnetic Data Results and Interpretation

The magnetic response usually varies between high and low values, that depends on the magnetic susceptibility of geological host materials and the hidden targets throughout the surveyed areas.

The response of gradient magnetic methods appears as various anomalies which indicates a variation in the medium, and was interpreted as archaeological
features. As shown in the Figure (2), the presence the some high magnetic anomalies, shown in red, aligned within the magnetic gradient map of the study area indicates an evidences for a potential archeological features.
Such features are probably buried extensions and mud walls that could be encountered at depths ranging between 20 cm to 60 cm.

Figure 2: Magnetic gradient map of the investigated site.

4.2. Electromagnetic Data Interpretation and Results

The electromagnetic response varies between high and low values, depending on the presence of magnetic or metals objects such as steel parts distributed over the surface of the investigated area, As shown in the Figure (3).

Figure 3: Electromagnetic map of the investigated site

5.0. Conclusion

The obtained results of the present geophysical survey matches to a great extent the results of archaeological excavation, As shown in the Figure (4). As observed from the top figure and the magnetic gradient & electromagnetic maps. Geophysical techniques help in exploring great archaeological sites in a short time at a lower cost, so we recommend conducting geophysical surveys prior to archaeological excavation.

6.0. Recommendation

Geophysical results of this study; provide a good information about hidden targets geometry and size, therefore we recommend a combined magnetic and electromagnetic surveys as a guide for archeological excavation activities.

7.0. REFERENCES


