ARCHAEOLOGICAL GEOPHYSICS INVESTIGATIONS OF THE VILLA DEGLI ANTONINI AND ROTA RIA ARCHAEOLOGICAL SITES

Klodian SKRAME[1] , Redi MUÇI[1], Oltion FOCIRO[1], Maria DI NEZZA[2] and Michele DI FILIPPO[3]

[1]*Polytechnic University of Tirana (UPT), Rruga Elbasanit, 1, Tirane, Albania; klodian.skrame@fgjm.edu.al*
[2]*National Institute of Geophysics and Volcanology (INGV), Via di Vigna Murata 605 - 00143 Rome, Italy*
[3]*Institute of Environmental Geology and Geoengineering (IGAG-CNR), Via Salaria km 29300 - 00015, Rome, Italy*

Introduction

A research approach that integrated different geophysical methods for archaeological prospection was carried out to understand the nature and chronological development of the curvilinear structure in the archaeological site of "Villa degli Antonini" (Genzano di Roma, Italy) (hereafter VA), and the finding of the settlement structure in the archaeological site of Rota Ria (Mugnano in Teverina, Viterbo, Italy) (hereafter RR) (SKRAME et al., 2016). To this purpose a detailed magnetic prospecting survey was carried out since the walls of the curvilinear structure are made of volcanic rocks, such as lava and tuffs of local provenience, that induce a very high degree of magnetization. Even in the RR archaeological framework, both the geological environment and the buried walls made of peperino and tuff blocks, suggested the use of magnetic prospecting survey.

In order to determine the exact shape and therefore the best excavation strategy for these buried archaeological structures, a series of different geophysical investigations (Electromagnetic (EMI) and Ground penetrating radar survey (GPR)) were carried out.

The final step of the investigation was the excavation in the targeted sector of the study areas in order to test the validity of the geophysical interpretations. The most interesting result was that, in both cases, the excavations have confirmed the results obtained during the magnetic surveying.

Methods

The magnetic data were collected using a Geometrics G856 in gradiometer configuration (two sensors mounted on a vertical staff at a distance of 1m apart). 1170 stations spaced at 1m intervals, with a sampling step of 1m and 250 stations spaced at 2m intervals, with a sampling step of 2m, were executed to cover an area of 2170 square meters in the VA test-area. Instead, the study area of the RR was divided into two sectors of variable size (west sector of 5200 square meters and east sector of 5000 square meters), that were surveyed separately. 1340 stations for the west sector and 1260 stations for the east sector, spaced at 1m intervals, with a sampling step of 1m, were executed in order to provide the maps of the vertical gradient of the magnetic field.

In order to obtain the lateral boundaries of the main causative sources of magnetic anomalies, a technique without the reduction-to-the-pole (RTP) was adopted. The map of magnetic anomalies (Fig. 1) was computed by the magnetic horizontal gradient operator (MHGO). The differential and integral calculus of the magnetic gradient operator (MGO) generates a grid of steepest slopes (i.e. the magnitude of the gradient) at any point on the surface. The MGO is reported as a number, which represent the amount of the magnetic anomalies in each square meters.

The EMI survey was carried out by means of the GSSI Profiler EMP-400 electromagnetic induction tool. The Profiler was configured to simultaneously measure up to three frequencies between 6 kHz and 16 kHz. The one meter spacing of EM traverses was chosen to delineate relatively small subsurface features. The system was deployed in horizontal dipole mode. Finally, a Ground penetration radar (GPR) survey was carried out to refine the EMI interpretation and identify the sources of EM anomalies. The GPR data were obtained by means of a GSSI Sir10B GPR system using an antenna with a center frequency of 400 MHz.

Results

The maps in Fig. 1 reveals the better resolution of the MHGO with respect to vertical gradient. In fact, in the case of the VA archaeological area the maxima of the vertical gradient are not able to delineate the

boundaries of the magnetic source and the information they bring is limited to a rough outline of the positions of the anomalies. More interesting results are instead obtained from the MHGO, whose maxima encircle a number of anomaly source bodies, delineating their boundaries. Even in the case of the RR test-area, the boundaries of the magnetic source inferred from the proposed technique are more impressive than those obtained with the vertical gradient of the magnetic field.

In order to test the validity of the geophysical surveys and understand the nature of the so called "curvilinear structure", we have so far excavate in two targeted sectors of the area of the anomaly called "Saggio A and Saggio C". "Saggio A and C" have confirmed that the curvilinear structure is indeed an roman amphitheatre. On the RR archaeological area, the excavation has confirmed the results obtained during the magnetic surveying, bringing to light the presence of two furnace and the structures of buried walls made of peperino and tuff blocks. A wall made of tuff blocks can be observed even from the western sector of the Rio creek.

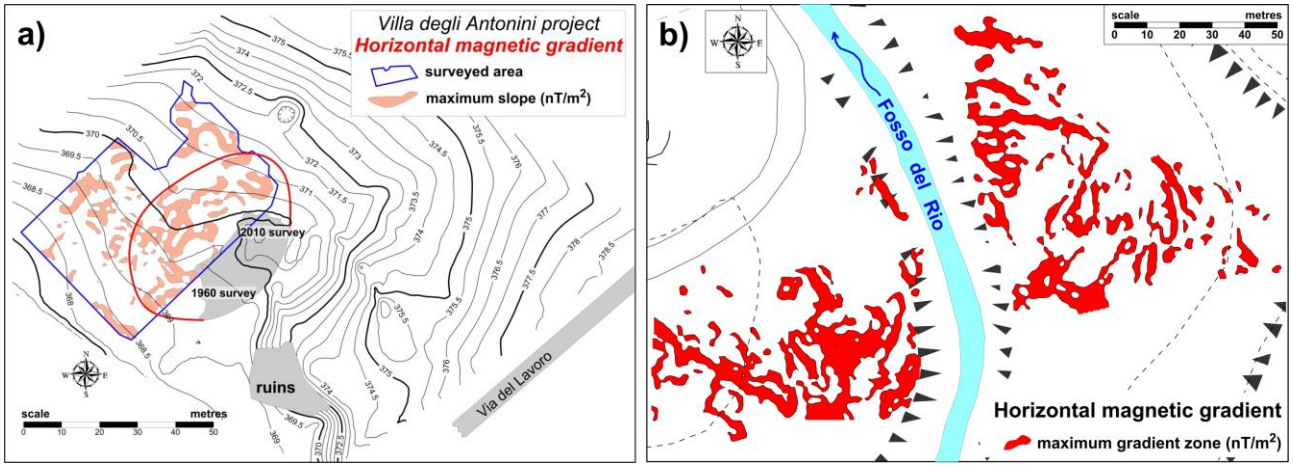

Figure 1. *a) The horizontal magnetic gradient map of the magnetic data for the VA archaeological area, b) The horizontal magnetic gradient map of the magnetic data for the RR archaeological area.*

Conclusions

In this paper, we presented an interpretation of the magnetic anomalies at both archaeological areas, caused by the distribution of the buried walls made of volcanic rocks, such as lava, tuffs and peperino of local provenience, that induce a very high degree of magnetization.

The application of the magnetic horizontal gradient operator (MHGO), will reduce the interference effects and at the same time will provide an enhance image and yield a more precise delineation of magnetic bodies. The results obtained have shown that the source boundaries locations are more precisely determined compared to those obtained with other known techniques which use the vertical gradient of the magnetic field. The results obtained with the EMI instrument allowed to identify areas with a major concentration of underground prominent structures. Finally, a GPR survey was carried out to refine the EMI interpretation and identify the sources of EM anomalies at a smaller scale and at different depths. The most interesting result was that, in both cases, the excavations have confirmed the results obtained during the magnetic surveying.

The authors think that this method, which has been successfully applied on these two archaeological areas, can be used as an efficient tool for the accurate interpretation of magnetic anomalies.

References

Skrame K., Di Filippo M., Di Nezza M., 2016. Contribution of the Magnetic Horizontal Gradient Operator (MHGO) for the Interpretation of the Magnetic Anomalies. Proceedings of 22nd European Meeting of Environmental and Engineering Geophysics – Near Surface Geoscience 2016. 4-8 September, 2016 Barcelona, Spain.