

Preliminary geophysical surveys and archaeological studies into the buried urban plan of the Lucanian settlement of Caselle in Pittari

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Abstract – The Lucanian settlement of Caselle in Pittari represents one of the most interesting and amazing archaeological sites located in the Southern Italy. The excavations realized in the last three decades have confirmed the presence of an important settlement including houses, workshops, fortification walls. With the aim to identify the urban plan of the site, an extensive geophysical campaign was carried out in the last two years. Results show how the integrated use of archaeological information and geophysical data allow to reconstruct the ancient urban plan of the site formed by orthogonal roads (*plateiai* and *stenopoi*) that neatly delimit the isolates (*insulae*).

I. INTRODUCTION

Nowadays, the application of geophysical methodologies in the archaeological field represents an unavoidable step for the comprehension of the archaeological sites, in particular during the preliminary phases of the archaeological activities. Among the various methods, the most effective for archaeological purposes are the ground penetrating radar and the magnetometric measurements (MAG), able to investigate with different detail (resolution and geometry) the structures buried in the first meters of the subsoil [1].

In particular, thanks to the possibility to investigate large surfaces, saving times and costs, MAG offers a great tool for the analyses of the archaeological sites less explored and known, as in the case of the Lucania territory [2-3]. Here, because the favourable position of this territory placed in the heart of the southern Italy, a great number of settlements flourished before the Roman age. One of the most important is surely the settlement of Caselle In Pittari located in the hinterland of the Gulf of Policastro (fig.1a).

II. THE CASE STUDY

The site of Caselle in Pittari (Fig. 1b) was discovered in the last century and during the last decades archaeological excavations have permitted to identify a site dated to IV and III century BC [4]. The site is placed on a plateau at 275 meters of altitude and is characterized by the presence of two plateau (on the top and on the bottom) and a necropolis placed on the near hill located on the west side of the area (Fig.1c). The archaeogeophysical researches are limited on the bottom of the plateau, that is an area totally public and owned by the Soprintendenza Archeologica. The absence of vegetation and the geological and morphological settings of the area, generally flat with gentle slopes, make the site particularly suitable for the geophysical acquisitions. Further, the presence of large constructions, generally realized with sandstones, as well as kilns and pottery (identified by old excavations), are able to generate a strong physical contrasts, theoretically detectable by the different geophysical methodology.

To date, the archaeological excavations here performed have highlighted the presence of important structures with sizes greater than 400 m² build up near the main path of the site with orientation north-south (*plateia A*), that crosses the two plateau. *Plateia A* is intersected by a second system of paths (called *stenopos*) orthogonal to it as confirmed also by the recent excavations. How the urban plan is developed represents, therefore, a fundamental information for the reconstruction of the history of the site and for planning the next archaeological activities to be performed in the area.

In order to identify the urban plan of the site, and consequently give detailed information about the presence of the archaeological features of the area, the support of the geophysics was required by the University of Salerno (UNISA) and magnetometric analyses are realized in the last years by the Institute of Methodologies for

Environmental Analysis (IMAA) of the Italian National Research Council (CNR).



Fig. 1: Localization of the archaeological site of Caselle in Pittari in Southern Italy (a), and its position with respect to the Gulf of Policastro (b). The site is characterized by two plateau, (top and bottom) flanked by a necropolis of the west side (c). The geophysical analyses are focused on the bottom of the site where

also archaeological activities are performed.

III. MAGNETOMETRIC ANALYSES

MAG is a geophysical methodology able to detect archaeological remains by analysing the variations of the earth magnetic field due to the different magnetic susceptibilities of construction materials and the magnetic characteristics of the shallow subsoil. By means of MAG, it is possible to investigate large subsurface areas in a relatively short time and identify the most significant archaeological anomalies [5].

MAG acquisitions are performed using an optical pumping magnetometer G-858 (Geometrics Instruments) in gradiometric configuration, with two magnetic probes set in a vertical direction at a mutual distance of about 1 m. Such a configuration allowed the automatic removal of the diurnal variations of the natural magnetic field. The two magnetic sensors are oriented after the necessary consideration about the survey direction and site location. To do this CSAZ software [6] has been used. Therefore, the instrument was set with a tilt angle of 90° and the survey was defined along parallel profile in N-S direction. Data are acquired along parallel profiles 1 m apart with a sampling rate of 3 Hz, obtaining a mean spatial resolution of $1.0 \text{ m} \times 0.125 \text{ m}$. A surface of 20000 m^2 was investigated according to the acquisition scheme showed in fig.2. This scheme was studied in according with the archaeologists to identify the urban plan of the site, and for this reason, the maps are acquired immediately close or above of the expected roads.

Further, all the acquisitions are supported by a topographical survey allowing a centimeter accuracy for the geophysical acquisition. Indeed, all the magnetometric acquisitions have been preceded by the tracking of regular polygons within which the measurements are carried out. The data are processed with the MagMap software to remove the zig-zag errors imputable to the operator walking. Then, the data are elaborated with the TerraSurveyor software [7]. In detail, the geomagnetic raw data have been filtered to increase the signal/noise ratio providing: a clip process, to remove extreme datapoint value; a de-spike filter, to remove spikes caused by small surface iron anomalies; de-stagger filter, to compensate for data collection errors caused by the operator starting recording each traverse too soon or too late; destripe process, to equalize underlying differences between grids and to reduce the linear features. Finally, the processed data are visualized in a regular grid using a Kriging interpolator with a linear variogram (Surfer software), to highlight the main magnetic anomalies



Fig. 2: The plateau investigated with MAG (in red the areas analyzed). The green rectangles show the areas, the results of which are showed in the paper.

IV. RESULTS

The preliminary results, obtained near the excavated segment of the *Plateia A*, unequivocally show interesting anomalies distributed on the entire investigated area, that are surely associable to the presence of ancient houses and factories. The measured geomagnetic anomalies ranged between 20nT/m and -20nT/m and some evident alignments are recorded. These events, for size and geometry, could be adequately connected to the presence of the urban plan of the city, composed by the regular presence of orthogonal roads (Fig. 3).

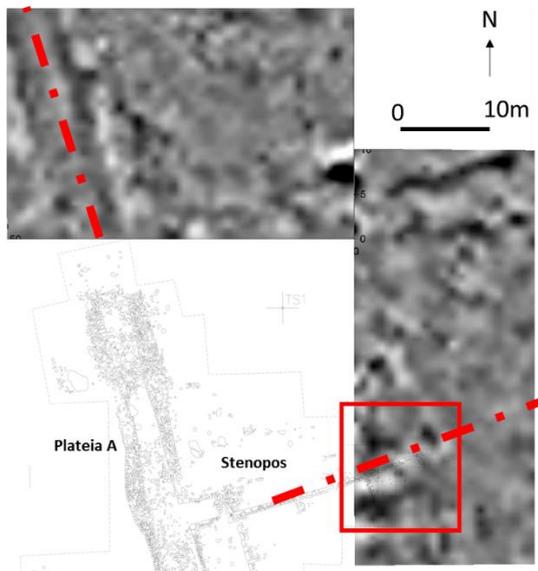


Fig. 3. Gradiometric maps acquired near the main excavated area of the site where the two orthogonal roads (*Plateia A* and *Stenopos*) are intercepted with indication of the main magnetic anomalies associable to their presence (red dashed lines). The red rectangle indicates the area recently excavated by the archaeologists after the measurements.

The first archaeological excavations realized close to the two linear and mutually perpendicular magnetic anomalies, imputable to the presence of the two main roads, have confirmed the geophysical results, highlighting their continuation in the two directions north-south (*plateia*) and west-east (*stenopos*). Further, a lot of archaeological features, linked to the presence of houses and structures and associated to punctual magnetic anomalies distributed near the two paths, are also identified as showed in figure 4.

The presence of kilns for the iron working or the pottery production, supposedly, explains the higher values recorded between the magnetic anomalies associated to the two roads.

The data interpretation of the geophysical results is also supported by the archaeological excavations realized in limited portions of the site after the geophysical acquisitions. In particular, the excavation 5, with sizes 5x5 m, have brought to the light the perimetral northern wall of the “*Casa in tecnica a scacchiera*”, highlighting the northern-eastern corner on the walls of the structure. Further, a fair amount of ceramic material was found including some ancient objects, such as a lamp and a vase in addition to iron nails [4].



Figure 4: The first materials recovered by the excavations after the geophysical measurements realized close to the *stenopos* intercepting the *plateia A* (excavation 5)

V. CONCLUSIONS

Results obtained with the use of magnetometric measurements in the archaeological site of Caselle in Pittari (Italy), show the great potentialities of the geophysical methodology adopted for the reconstruction of the urban plan. Further, a great number of magnetic anomalies, often distributed regularly in the urban plan of the site, testifies the presence of the importance of Caselle in Pittari for the knowledge of the settlement dynamics during the pre-Roman age in the Lucania territory.

Future geophysical activities, based on the integration of ground penetrating radar measurements and electromagnetic analyses will give new impetus for the archaeological research providing fundamental

information about the shape and distribution of the buried structures placed in the urban plan admirably detected by the first magnetometric analyses.

REFERENCES

- [1] Rizzo, E., Santoriello, A., Capozzoli, L., De Martino, G., De Vita, C. B., Musmeci, D., Perciante, F., Geophysical survey and archaeological data at Masseria Grasso (Benevento, Italy), *Surveys in Geophysics* 2018 doi:10.1007/s10712-018-9494-y;
- [2] Rizzo, E., Chianese, D., and V. Lapenna (2005). Magnetic, GPR and geoelectrical measurements for studying the archaeological site of 'Masseria Nigro' (Viggiano, southern Italy). *Near Surface Geophysics*. Vol 3, No 1, February 2005 pp. 13 -19 DOI: 10.3997/1873-0604.2004025
- [3] Capozzoli, L., Mutino, S., Liseno, M.G., De Martino, G., Searching for the History of the Ancient Basilicata: *Archaeogeophysics Applied to the Roman Site of Forentum*. *Heritage* 2019, 2, 1097-1116, doi:10.3390/heritage2020072
- [4] Serritella, A., Rizzo, M. L., (2019): "Nuove ricerche a Caselle in Pittari" *FOLD&R Fasti On Line Documents & Research*, 439, 2019;
- [5] Aspinall, A., Gaffney, C., Schmidt, A., (2008) *Magnetometry for archaeologists*. Geophysical methods for archaeology. Altamira Press, Lanham, pp 189–201
- [6] CSAZ Operation Manual, available on line at the link: https://geometrics.com/wp-content/uploads/2018/10/csaz_manual.pdf
- [7] Terra Surveyor, Program version 3.0.29 DW Consulting available online at the link https://arf.berkeley.edu/files/webfiles/all/arf/equipment/field/geophysical/magnetometer/terrasurveyor_manual_3029.pdf