2025 IMEKO TC26 International Conference on
Metrology for Archaeology and Cultural Heritage
Bergamo, Italy, October 15-17, 2025

GPR survey at the archaeological site of Heloros (Noto, Sicily)

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***Abstract* – Results related to GPR survey at the archaeological site of the ancient Greek city of Heloros, located on the southeastern coast of Sicily near modern-day Noto. Data analysis demonstrates the abandonment of a remarkable settlement by highlighting the presence of various wall structures.**

I. INTRODUCTION

The ancient Greek city of Heloros, located on the southeastern coast of Sicily near modern-day Noto (ig. 1), was founded in the 7th century BCE ca. as a sub-colony of Syracuse. Its strategic placement along the Heloros River and near key coastal routes made it an important satellite in the territorial expansion and consolidation of Syracusan power. Archaeologically, Heloros presents a rich assemblage of remains that reflect its dual identity as both a military outpost and a rural settlement. Excavations have revealed a well-planned urban layout with defensive walls, residential quarters, sanctuaries, and a notable Hellenistic theatre, suggesting both civic and cultural vitality. The presence of monumental architecture, including a large temple and public buildings, as well as a necropolis with elaborate tomb types, points to a degree of urban sophistication and integration into broader patterns of Greek colonial life in Sicily. Heloros also provides evidence of continued occupation into the Roman period, indicating its sustained regional significance beyond the classical Greek era.

A field work carried out by the ISPC-CNR in four areas at the archaeological site of Heloros (Fig. 1) was carried out to inform future excavation campaigns for the documentation, representation and preservation of the archaeological contexts. The scientific rigor and accuracy of the traditional instrumental mapping together with the use of geophysical methods have produced high-definition 3D models of the surveyed areas as tools to store and manage scientific information. The aim of such a geophysical survey was to obtain information about the buried archaeological structures.

II. RESULTS AND DISCUSSION

The survey was carried out on 4 areas (1-4) of the archaeological site of Heloros (Fig. 1). In all areas the georadar measurements were performed by acquiring data along parallel and equidistant profiles $\Delta y = 0.5$ m. All profiles were acquired with 512 samples/track; the time windows were set to T = 120 ns. The other acquisition parameters were optimized on site and kept constant for all profiles of each survey. The quality of the data was found to be disturbed by the presence of cut, shredded and not removed grass (Fig. 2). In this paper the results related to the Area 1 (Fig. 1) will be presented.

Area 1 is a rectangle measuring 70 m x 42 m. 107 profiles were acquired for a total length of 3367 m (Fig. 3). Due to the presence of shrubs, some areas were not surveyed (Fig. 3). The data analysis highlighted (Fig. 4):

- a signal penetration reaching 2.8 m in depth (with an electromagnetic wave propagation speed of 0.07 m/ns);
- reflected events, indicated by the letter A (depth z = 0.8-1.0 m that could be associated with the presence of probable structures of archaeological interest.

The planimetry of the profiles allowed the analysis through depth slices [1-3]. The depth slices represent a sort of virtual excavation within which the anomalies present on the 2D sections at various depths are correlated (see the appendix). The gray color indicates weak amplitude of the reflected signal, while the colors from dark gray to black indicate variations in the amplitude of the reflected signal. The variations in amplitude (therefore of color) in the same slice are indicative of horizontal variations in the electromagnetic characteristics of the investigated materials. In Fig. 5 the most significant depth slices are reported with indication (red dotted lines) of the anomalies. The anomaly "A" identified in the section in Fig. 4 is located in the slices at depths between 0.4 m and 1.0 m. In particular, in the depth slices 0.4-0.6 m and 0.6-0.8 m, an anomaly with concentric semicircles can be seen (indicated by the red arrows), while in the depth slice 0.8-1.0 m, a series of probably masonry structures can be seen. Fig. 6 shows the pseudo 3d visualization that show the 3D development of the archaeological structures.

Fig. 1. The archaeological site of Heloros with the surveyed areas

Fig. 2. Photo related to the phase of data acquisition.

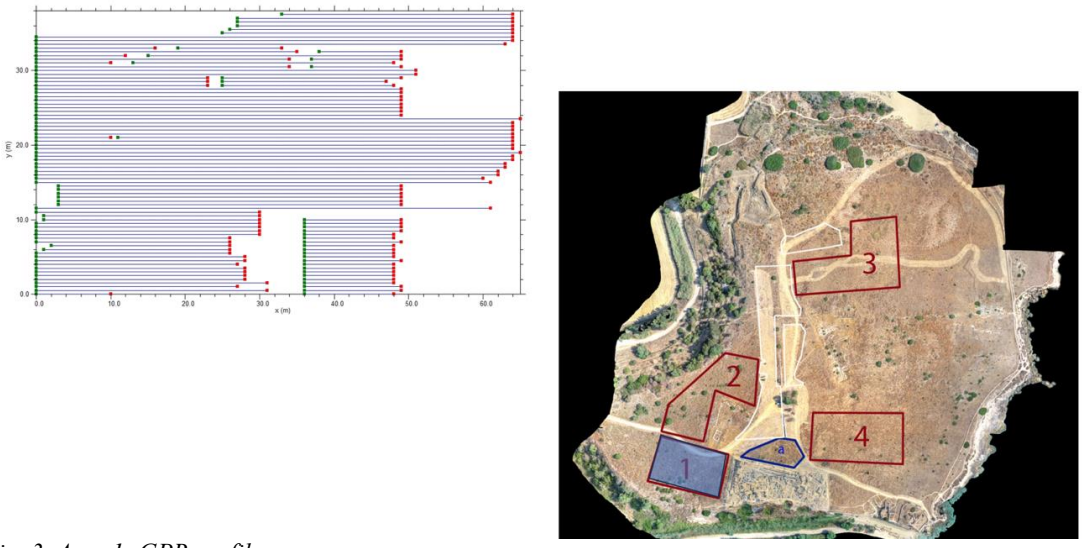

Fig. 3. Area 1: GPR profiles.

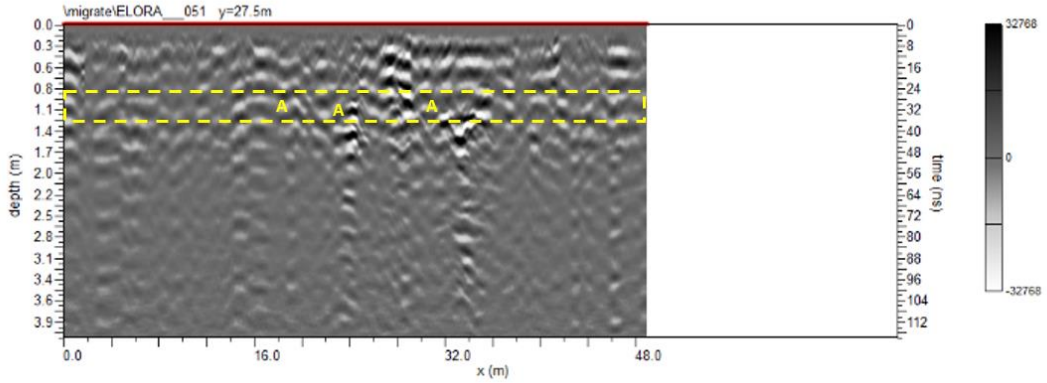

Fig. 4. Area 1: processed radar section

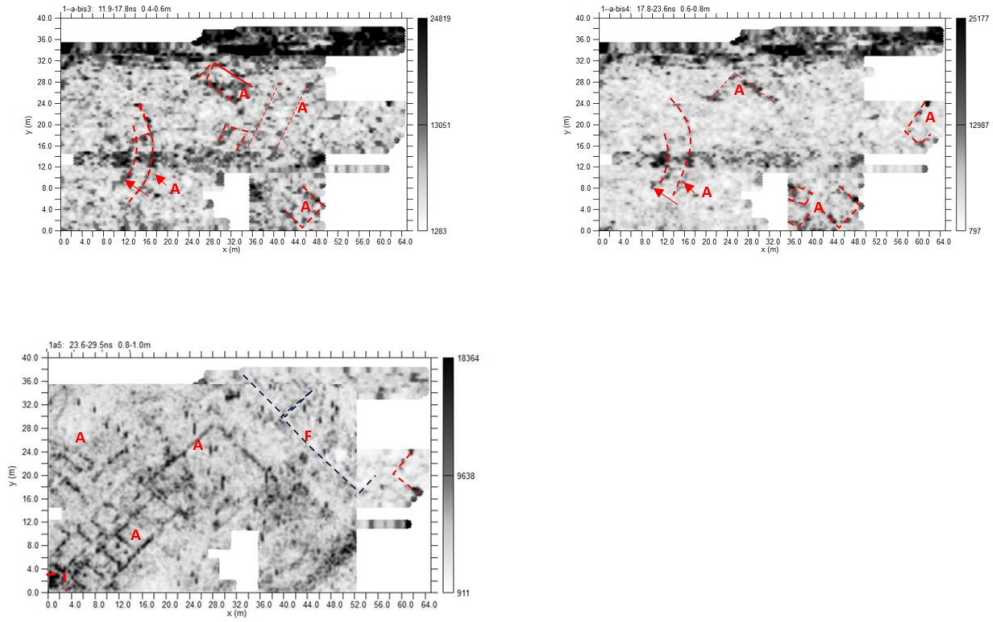

Fig. 5. Area 1: most significant depth slices with indication of anomalies: A: probable masonry structures; F: probable foundations related to masonry structures

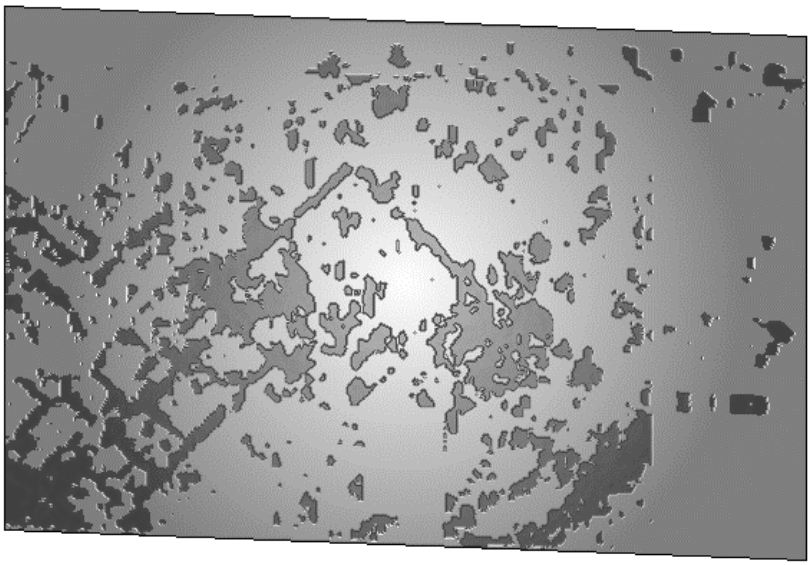

Fig. 6. Area 1: Amplitude isosurfaces

III. CONCLUSIONS

This work allowed us to highlight the importance of geophysical survey methods in the study of areas that hide elements of archaeological interest: non-invasive methods that define the areas with the presence of archaeological structures before excavation. The presence of cut grass

(shredded) created some problems during the data acquisition phase by increasing the noise component (ringing and antenna bounces) present within the radar sections. The presence in the investigated areas of a dense clusters of bushes (protected) has limited the investigable surface. The application of the high-resolution impulsive electromagnetic methodology has in fact allowed us to understand the layout and arrangement of the probable structures of archaeological interest present in the investigated areas. In all the investigated areas, the geophysical survey has highlighted the presence of a series of anomalies at various depths probably linked to the presence of structures dating back to different periods.

REFERENCES

[1] Conyers LB. 2006. Innovative ground-penetrating radar methods for archaeological mapping. Archaeological Prospection 13(2): 139–141.

[2] Leucci G., 2019, Nondestructive Testing for Archaeology and Cultural Heritage: A practical guide and new perspective. Springer editore pp 217, ISBN 978-3-030-01898-6.

[3] Reynolds, J.M. 2011: An Introduction to Applied and Environmental Geophysics, 2nd Edition. Wiley ISBN: 978-0-471-48535-3