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Electromagnetic survey at the Messapian necropolis in Alezio (Lecce, Italy).

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***Abstract* – The Messapian necropolis of Monte d'Elia is related to one of the most important ancient settlements in the Salento Peninsula (in south Italy). In order to understand the extension and layout of this necropolis in the various periods of its use, an electromagnetic prospection was undertaken in an area adjacent to the necropolis. The analysis of the electromagnetic data revealed many anomalies that could be ascribed to archaeological structures (tombs).**

I. INTRODUCTION

The present study concerns an area adjacent to the Messapian necropolis of Monte d'Elia, located about 300 m south of the ancient settlement named *Aletium* (Fig. 1). It was inhabited between the late Iron Age and the Roman-Imperial era and lies where modern Alezio stands. The necropolis, used between the 6th and the 2nd century BC, was partially investigated between 1981 and 1985 by archaeological excavations, but the discovered tombs were subsequently buried. Later, a part of the excavated areas was again brought to light and the necropolis became part of an archaeological park [1,2] .

The almost complete overlapping of the modern town on the ancient settlement and most of its necropolises greatly limits the reconstruction of the various phases of historical development of *Aletium*, as demonstrated by the recent archaeological map of the site [3]. Only part of the grave goods has been studied and neither the extension or the topographical articulation of the necropolis of Monte d'Elia is known, since archaeological excavations have only partially investigated. The present research aims to study the extension of necropolis using geophysical method. Geophysical survey was carried out by means of the CMD multi-depth electromagnetic (EM) conductivity meters instrument. EM conductivity meters simultaneously measure apparent conductivity (quadrature component) and apparent magnetic susceptibility (in-phase component), and comprise of a transmitting coil, and 3-4 receiving coils, for the acquisition of the data The transmitting coil generates a time varying primary magnetic field, which propagates above and below ground, generating alternating currents (eddy currents) within the soil and the objects it contains. These eddy currents create a secondary magnetic field which is proportional to the rate of change of the primary magnetic field, and measured by receiving coils mounted at set distances from the transmitting coil [4,5]. In an archaeological study, resistivity variations, that could be obtained by EM measurements, between soil types and stones are important, whereas in geological studies these variations are generally important between the different rock types. The EM imaging technique has recently become an efficient tool in investigating shallow archaeological structures [4,5]. The EM method was applied to display buried archaeological structures at line intervals of 0.5 m.

II. GEOPHYSICAL DATA ACQUISITION AND PROCESSING

The electromagnetic (EM) measurements were taken using the CMD multi-depth electromagnetic conductivity meters by GF instruments (Fig. 2). Data were acquired in a grid with parallel profiles spaced 0.5 m.

The EM acquisition was supported by a topographic survey that gave the possibility to georeference the obtained data that were managed with a Gis software. A Res3Dinv software was used in order to obtain the inverted resistivity depth slices [4].

Electromagnetic methods detect the electrical properties of the subsurface by inducing EM energy within the subsurface and measuring the response of earth materials. The EM used instrument output a time-varying electric current into its transmitter coil.

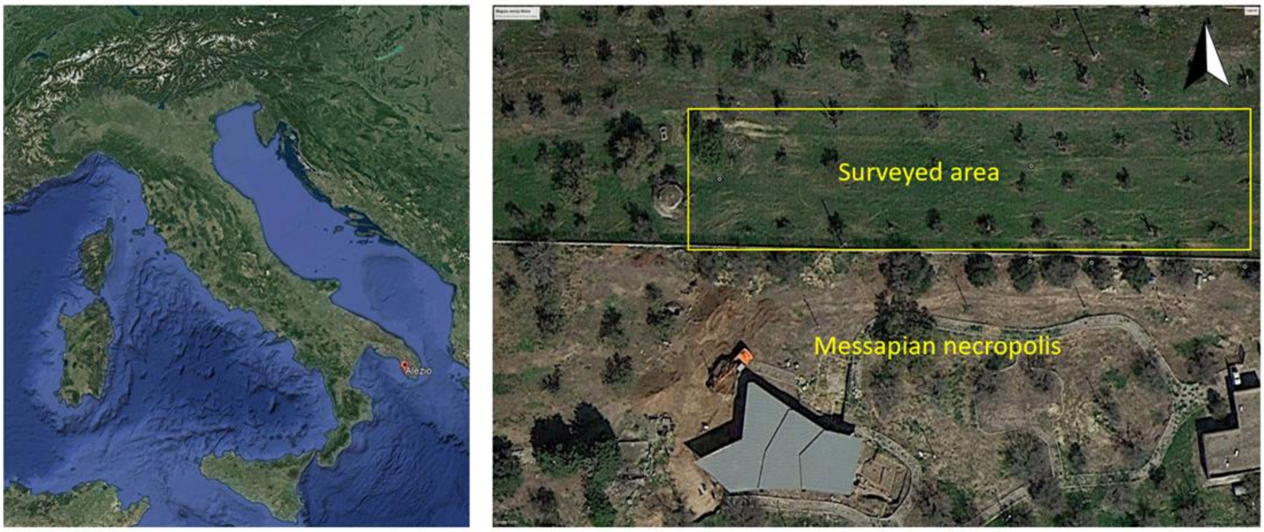

Fig. 1. Alezio, localization of the area investigated using electromagnetic instrumentation.

Fig. 2. Photo relating to the measurement phases with an electromagnetometer.

As the current travels in the transmitter loop, it generates a magnetic field that has the same frequency and phase as the current. This induced field propagates lines of force that penetrate the earth. If a conductive body or conductive material exist in the vicinity of the instrument, an electromotive force (i.e., voltage) forms within it (i.e., *Faraday's Law*). Electrical current flow is then initiated within the subsurface conductors, and a secondary magnetic field is generated. The secondary field is detected by the receiver coil of the EM geophysical instrument, which compares this received energy to the transmitted energy and records the data. These data are then processed and interpreted to characterize the subsurface EM properties. Subsurface EM energy is propagated due to the three electromagnetic properties of matter: electrical conductivity, dielectric permittivity, and magnetic susceptibility. Electrical conductivity and magnetic susceptibility govern the magnitude of the received EM signal and, therefore, are used to understand the electrical properties of subsurface materials [5].

The results of EM processed data are show in Fig. 3.

EM results provided an identification of several resistivity anomalies related to the presence of a significant buried archaeological structures (Fig. 4). In detail, the resistivity depth slices shows several low resistivity (5-15 ohm m) anomalies potentially related to the presence of buried structures: they probably prove the presence of tombs (T) dug out of the rock and filled with earth. They are visible at depth between 0.35 m and 1.7m. Other low resistivity anomalies (A) could be related to a series of tombs one beside the other. The continuity can be linked to a low resolution of the instrument. In Figure 4 the georeferenced data are shows. It is possible to see the position and orientation of the tombs that is similar to the excavated tombs in the adjacent necropolis.

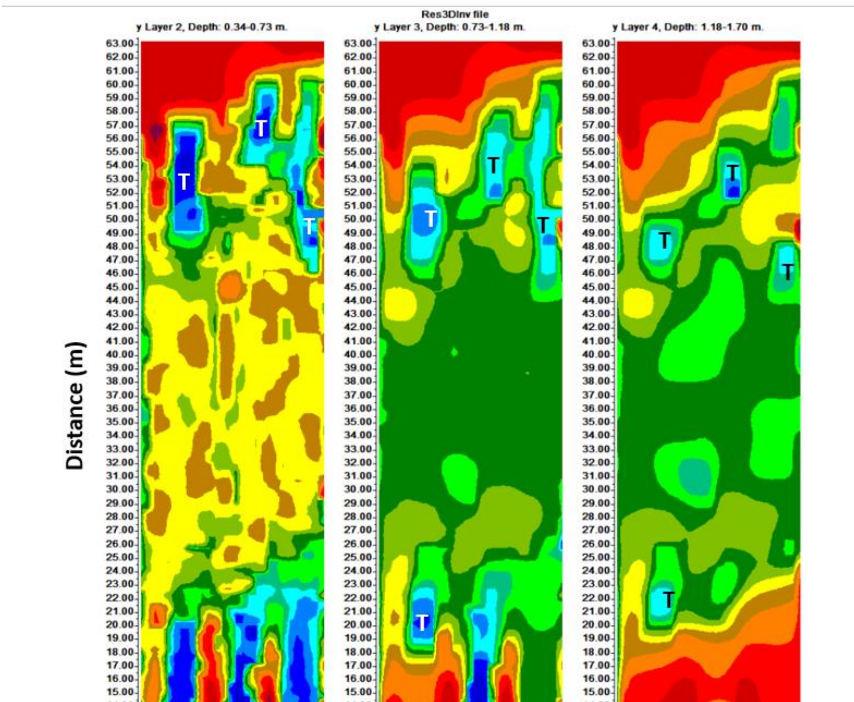

Fig. 3. EM data: resistivity distribution at several depths.

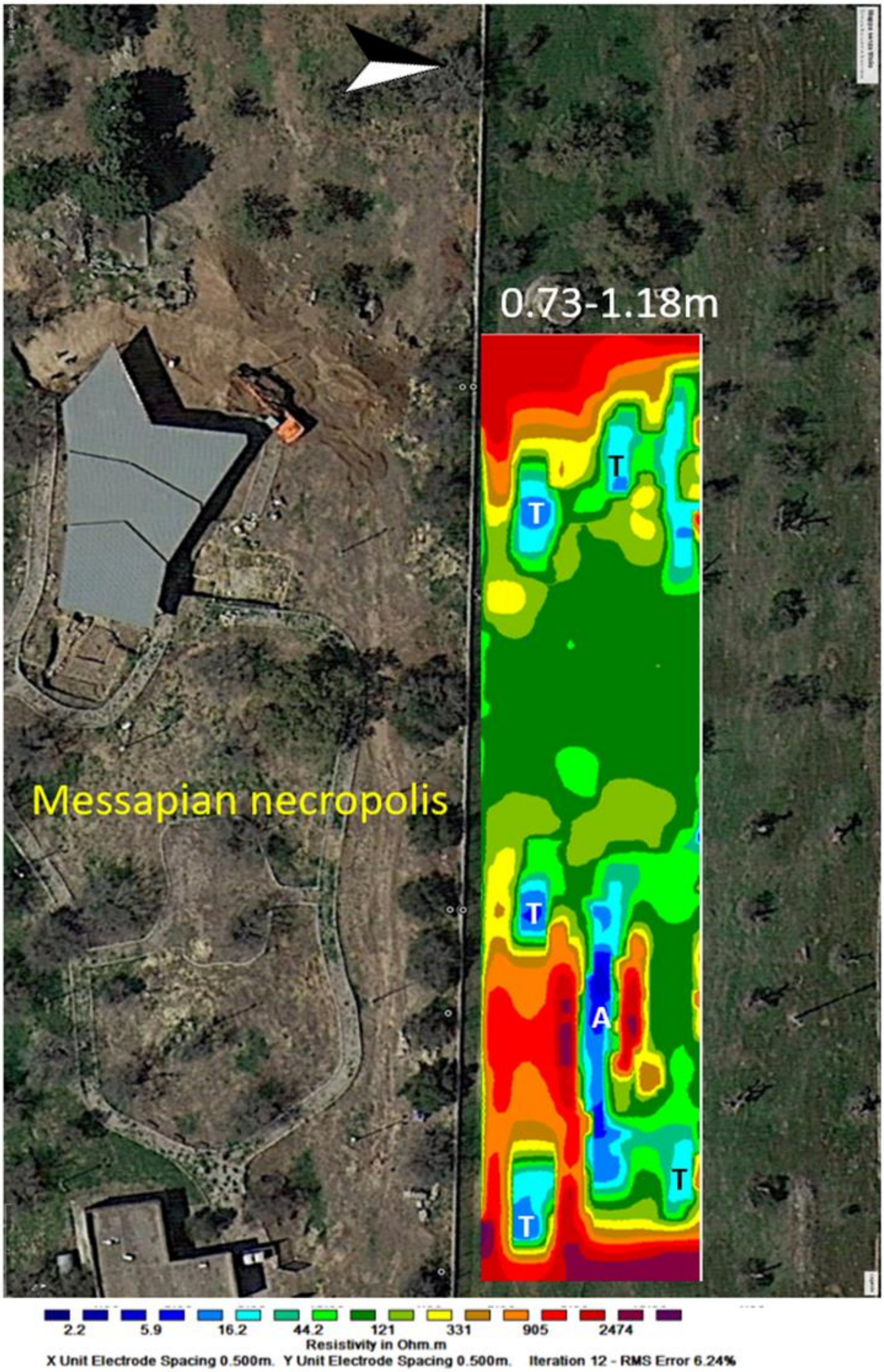

Fig. 4. Georeferenced depth slices (0.73 - 1.18 m).

III. CONCLUSIONS

Geophysical surveys carried out in the area adjacent to the Messapian necropolis of Monte D'Elia allowed for the collection of important new data on the extension of the funerary area. The geophysical prospecting allowed to highlight numerous anomalies, many of them with archaeological interest, related to the tombs unknown and yet to be explored. The identification of the new tombs was possible thanks to the georeferencing of the depth slices from EM investigations in the new archaeological map of the necropolis. The presented approach, based on the use of geophysical methods highlights how it is a good starting point for planning excavation activities saving time and money.

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REFERENCES

[1] L.De Giorgi, I.Ferrari, F.Giuri, G.Leucci, G. Scardozzi, "Integrated Geoscientific Surveys at the Church of Santa Maria della Lizza (Alezio, Italy)", Sensors 2021, 21(6), 2205.

[2] G.Leucci, L.De Giorgi, I.Ditaranto, F.Giuri, I. Ferrari, G.Scardozzi, "New Data on the Messapian Necropolis of Monte D'Elia in Alezio (Apulia, Italy) from Topographical and Geophysical Surveys", Sensors 2019, 19(16), 3494.

[3] I.Ferrari, G.Scardozzi, "Contributo Alla Carta Archeologica di Alezio", Bari, Italy, 2016.

[4] G.Leucci, "Nondestructive Testing for Archaeology and Cultural Heritage: A practical guide and new perspective", Cham, Switzerland, 2019, pp. 217.

[5] F.Giannino, G.Leucci, 2021, "Electromagnetic Methods in Geophysics: Applications", GeoRadar, FDEM, TDEM, and AEM, Wiley, p. 352.