

Underwater geophysical prospection in ancient Olous, Crete

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Abstract

We employ electrical resistivity tomography and magnetic gradiometry methods to the ultra-shallow submerged and littoral archaeological site of Olous. This allows reconstruction of the built environment that nowadays lie below the sea bottom, thus completing the respective archaeological evidence.

Keywords

ancient Olous; archaeological prospection; ERT; multisensor magnetic gradiometry; shallow marine and littoral geophysics

Introduction

Elounda is located on the eastern coast of Lasithi, Crete, near the regional capital of Agios Nikolaos. Archaeological findings in ancient Olous attest to the fact that the area was inhabited at least since the Archaic period. Minoan tombs have been found in the wider area, while recovered scriptures from Hellenistic times reveal the existence of a great harbor city during that time expanding in the Isthmus region that connects the Kolokytha peninsula with Elounda Bay (Apostolakou et al. 2009). A significant part of the city lies nowadays under water since the isthmus was narrowed due to sea levels variations. Previous geophysical investigation in the area (Symirdanis et al. 2016) showed promising results and useful information about the efficiency of the electrical resistivity tomography in locating submerged archaeological remains.

The geophysical survey was focused on the shallow part of the sea and the littoral area of Schisma Eloundas. It was carried out during a period of time between the summer of 2019 and the winter of 2022. The main target of the investigation was the mapping of buried underwater and inland archaeological remains and structures in the broader archaeological area of ancient Olous, in an effort to complete the picture of the built environment of the submerged city.

Methodology and instrumentation

For the scope of the investigation the electrical resistivity tomography (ERT) method was implemented in two different ways. Concerning the dynamic mode, the dipole-dipole array with one meter spacing between the electrodes was used to collect data along 27 lines, covering approximately 10,000 m² of marine area in the southern bay. The static variation of the ERT method applied in two grids, along multiple parallel transects of one-meter distance, in the northern bay using the pole-dipole electrode configuration with one-meter electrode distance. A high-resolution bathymetric model was produced in order to be integrated along with the conductivity of the sea water in the 3D robust inversion algorithm (Loke et al. 2020) that was used for data processing. The bathymetry was also incorporated in the algorithm for locating the position of the electrodes in the dynamic mode (Oikonomou et al. 2019).

More than 11,900 m² in the very shallow areas of both sides of the Isthmus that connects the Kolokytha peninsula with the Elounda Bay, were investigated with magnetic gradiometry. A multichannel system consisting of five gradiometers placed on a frame in 50 cm crossline separation was assembled, while the resolution of the measurements along each track was about 10 cm.

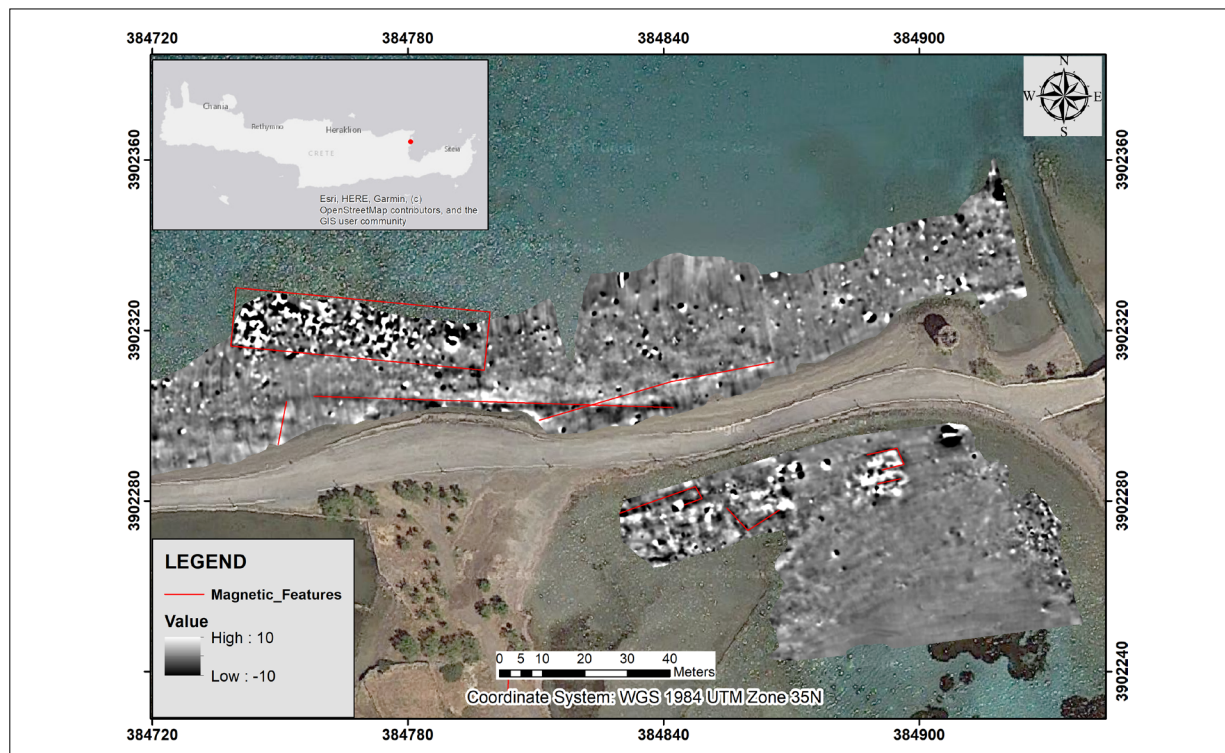


Fig. 1: Diagrammatic interpretation of the magnetic results at the north and south areas of Olous Bay (base map: Google, map data ©2013 Google). Units are nT. Axis units are in meters.

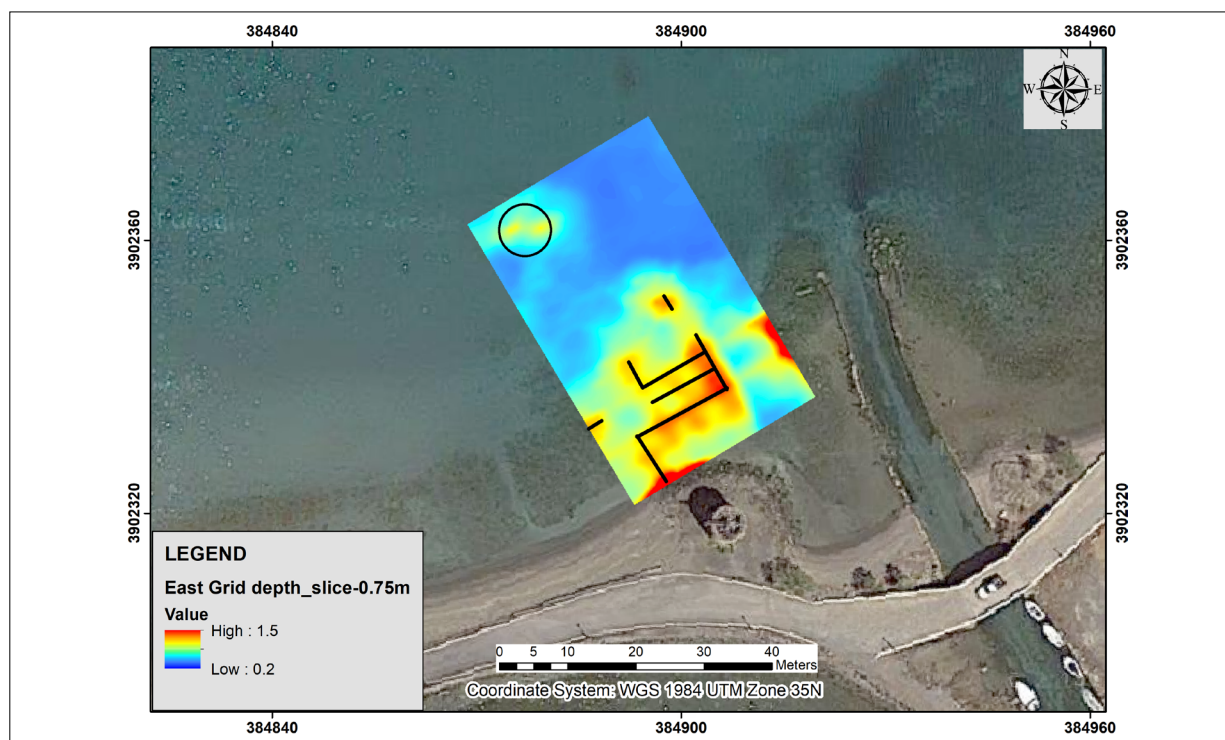


Fig. 2: Diagrammatic interpretation of the 3D inversion results at the East Grid of ancient Olous at a depth of about 0.75 m below the sea bed (base map: Google, map data ©2013 Google). Units are Ohmm. Axis units are in meters.

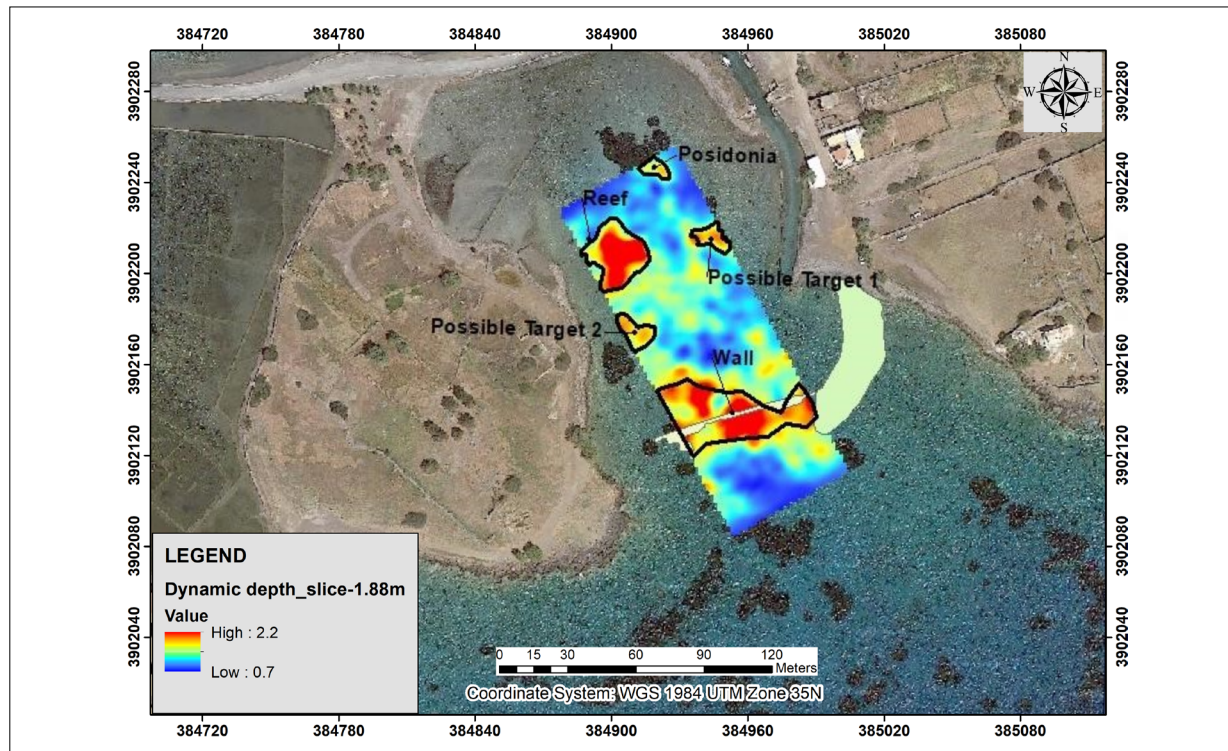


Fig. 3: Diagrammatic interpretation of the 3D inversion results of the Dynamic ERT method at the southern bay of ancient Olous at a depth of about 2 m, with the rectification of the identified wall for the archaeological survey (base map: Google, map data ©2013 Google). Units are Ohmm. Axis units are in meters.

Results

The processed magnetic map in both bays managed to reveal relatively small variations of the magnetic gradient. The geometry and their orientation aligned with visible structures on the sea bottom enhance the possibility that these features represent archaeological structural elements (Fig. 1). Concerning the static ERT results, many interconnected linear resistive targets were revealed. These targets are highly probable to form some sort of buried underwater structure, such as a public building or walls. Some of the targets could be verified in situ since they could be identified by archaeological inspection through diving. Finally, some resistive targets related to the presence of beach rock were also identified (Fig. 2).


Furthermore, the results of the 3D inverted dynamic ERT lines in the southern Olous Bay showed quite promising results. The horizontal depth slices managed to pinpoint the lateral and vertical continuation of a possible fortress wall, part of which has already been identified and mapped by the underwater archaeological diving survey. The slices show a much longer and wider wall than what

was originally believed. Moreover, a cluster of Posidonia plants and a visible reef were also identified in the slices. The existence of two further buried resistive targets in the respective depth slices could also indicate respective anthropogenic structures since there is no relevant evidence that could support the geological origin of these bulky resistive anomalies (Fig. 3).

Conclusion

The results of the underwater geophysical survey at ancient Olous are quite promising, since both magnetic and electrical resistivity tomography managed to reveal interesting archaeological features providing useful information on the ancient city of Olous. The fact that those two methods can be successfully applied in shallow marine environment for mapping submerged archaeological remnants is very important, introducing an extra tool for archaeological surveys in this demanding environment.

Acknowledgments

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