Coastal Geoelectrical Survey at the Ancient Harbor of Lechaion (Greece)

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Introduction – Location - Geology

The study area is located at coastal area of the Ancient Harbor of Lechaion, at the area of the outer harbor moles (Figs. 1-2), in order to investigate a possible extension of the existing ancient settlements. It is located on the southeastern coast of the Corinthian Gulf, 3km to the west of the modern city of Corinth, Greece. The construction of the Ancient Harbor dates to the 6th-7th century BC and archaeological evidence suggest that its use continued throughout the Roman period (Rothaus, 1995; Stiros *et al*., 1996).

Lechaion harbor site lies in the southern coastal area of the Lechaion Gulf (Fig. 1). The broader area comprises alluvial and coastal deposits including loose materials, sands, pebbles and gravels (Papanikolaou *et al.,* 1998). The geophysical survey was carried out in an area lying approximately 3 km west of the modern city of Corinth and consisting of recent beach deposits including sands and gravels (Papanikolaou *et al*., 1998). They are cohesive at places making up beach rocks.

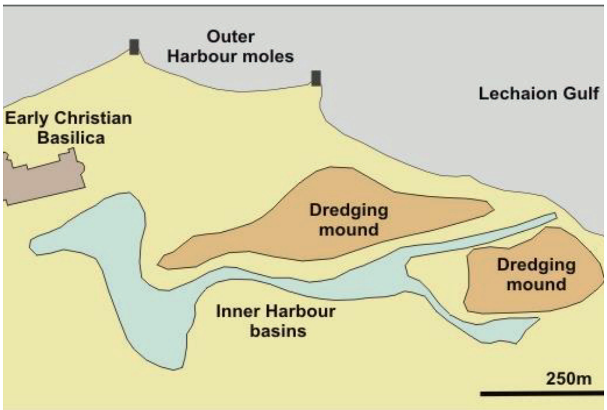

Figure 1. The Ancient Harbor of Lechaion (Minos-Minopoulos *et al.,* 2013) and location of the study area.

Figure 2. Location of the ERT sections

Geoelectrical research

Three (3) profiles were carried out (Fig. 2) by applying the Electrical Resistivity Tomography technique, which is indicated for the investigation of buried archaeological settlements (Alexopoulos *et al.,* 2014). The total length of investigation was 224 meters. Section "Lexaio-1" was 96 meters while sections "Lexaio-2" and "Lexaio-3" were 64m length each one. The roll-along technique was applied in order to reach the desired length and depth of investigation. The Wenner array was chosen with minimum electrode spacing equal to 0,40 meters. A total number of 3.610 data points were collected from all three ERT sections, investigating the subsurface resistivity distribution. The instrument used for the field measurements was the ABEM Terrameter Unit*,* supported by the Lund Imaging System.

The resistivity data points that were collected during the field campaign were processed with Res2DInv Software (Geotomo). During the processing, the software tries to minimize the misfit error of an arbitrary model, checking the raw data points. The inversion process is continuously repeated until the minimum possible misfit is reached. The robust inversion was used, as the most appropriate for such geoenvironments and targets.

During the set-up of the two geoelectrical lines, the coordinates of each electrode have been determined using Differential Global Positioning System (*dGPS*) and Real-Time Kinematics (RTK) technique. The topographic relief must be taken under consideration in such investigations and should be embodied in the inversion procedure of the ERT measurements. The geodetic system used for the coordinates was the local (Greek) EGSA'87 (Datum GGRS'80).

Results and Discussion

In Section 2 (Fig. 3), a dominant geoelectrical formation of low resistivity (<50 Ohm.m) has been investigated, from the depth of 2m up to the maximum depth of investigation which is equal to almost 6,0 meters. At shallow depths (<2 meters), resistant formations (500-2000 Ohm.m) have been determined along the section (Fig.3-red dashed rectangulars). It should be mentioned that along the main resistant formation (17,0-40,6m.) the highest resistant zones are adumbrated clearly (reddish colors) illustrated with almost sharp boundaries.

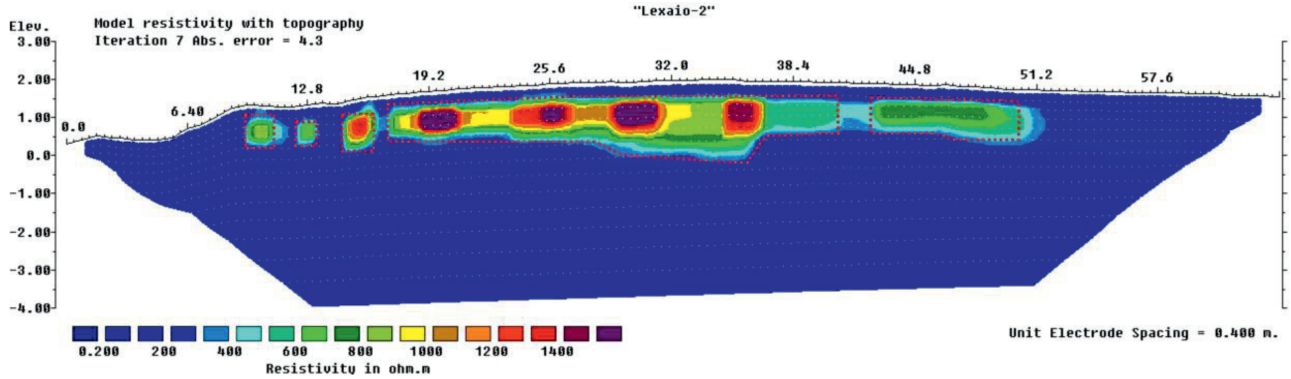

Figure 3. The resistivity model of Section-2 (7 iterations, RMS=4.3%) in scale 1:2.

In Section 3 (Fig. 4), even though the general image is similar, the resistant formations are quite bigger in size. The dominant geoelectrical formation of low resistivity (<100 Ohm.m) has also been investigated, extending mainly from the depth of 2,5 meters to the maximum depth of investigation which is equal to almost 6,0 meters. In this section, between 38,4-51,0 meters the aforementioned conductive formation is interrupted by a relatively resistant zone with values close to 400 Ohm.m. At depths less than 3,0 meters, highly resistant formations (550-6500 Ohm.m) have been determined along the section (Fig.4-red dashed rectangulars). It should be mentioned that two main resistant formations have been investigated (5,6-28,6m. and 30,0-64,0m), from depths 0,2-1,8m. and 0,4-4,0m equally. Along the first main resistant formation the highest resistant zones (>1500 Ohm.m) are adumbrated clearly (purplish colors) and are illustrated with almost sharp boundaries. Concerning the second major resistant zone, almost all the resistivity values are above 2000 Ohm.m (purplish colors). The geoelectrical boundaries here are also quite sharp and clear.

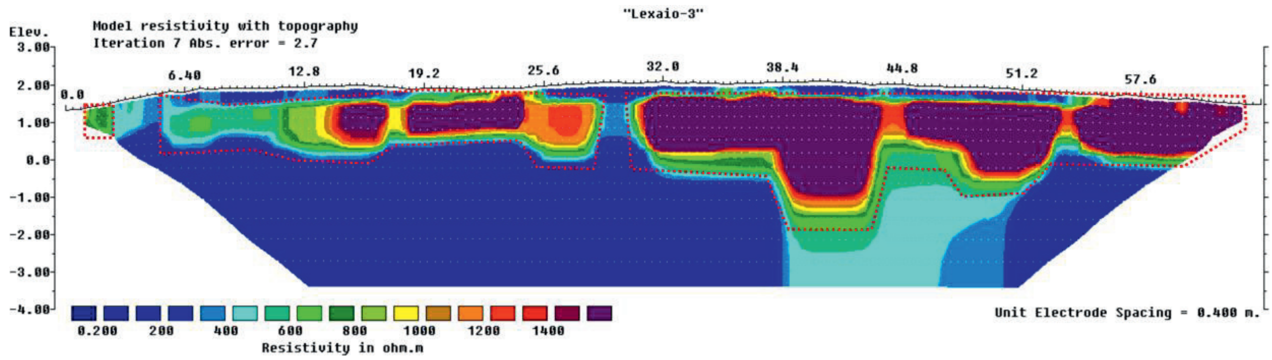

Figure 4. The resistivity model of Section-3 (7 iterations, RMS=2.7%) in scale 1:2.

Conclusions

The results of the geoelectrical survey seem to adumbrate some zones (Figs. 3-4, reddish & purplish colors) that could be interpreted as archaeological remains of the coastal installations of the ancient foreharbor. These are presented and discussed by Mourtzas *et al.* (2014) in the context of the geoarchaeological approach of the ancient harbor of Lechaion.

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