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3D RESISTIVITY IMAGING IN ARCHAEOLOGICAL PROSPECTION: AN EXAMPLE FROM ANCIENT SITE OF PARION (BIGA-TURKEY)

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ABSTRACT In the summer season of 2006, 2D electrical resistivity tomography survey has been applied to detect burial remains at the archaeological site of Parion (Biga-Turkey). The survey was performed in two different areas of necropolis named Area1 and Area2. This paper gives the results of the archaeogeophysical survey from Area2. 2D inversion approach was used to interpret the data set obtained from 11 pole-dipole resistivity profiles. A MATLAB code was developed to present the result of 2D inversion of each profile jointly in a 3D volume. By using 3D resistivity imaging technique, representation of the lateral and vertical continuities of the anomalies of possible archaeological features was easily provided. Taking into account the existing archaeological features in the field the highest resistivity zones seen in the 3D volumetric sections were suggested as the most promising locations for archaeological excavation.

INTRODUCTION

In this paper, an example is given from the site of Parion in ancient Troas. The site is located some 90 km northeast part of Çanakkale (northwest Turkey) (Figure-1). Part of the site is now occupied by the village of Kemer, which lies within the administrative district of Biga. The site was investigated during rescue excavations completed by the Çanakkale museum in 2004, and systematic excavations began in 2005 under the direction of Archaeological Department of Atatürk University. There are many types of burials, from simple pithoi to sandstone sarcophagi at the site, dating from the first half of the 4th century BC to the Roman period.

The electric resistivity tomography (ERT) is a geo-electrical method frequently applied to obtain 2D and 3D high resolution images of the resistivity subsurface patterns in complex areas (Griffiths and Barker 1993; Dahlin 1996). The method has become an increasingly efficient tool to investigate buried archaeological features at differing depths (e.g. Candansayar and Basokur, 2001; Candansayar et al., 2001; Drahor, 2006; Ekinci et al., 2007). The aim of this technique is to survey the subsurface along the survey line repeatedly by a selected electrode array. By this way, the line of electrodes is scanned quickly to obtain the apparent resistivity pseudo-sections from the first electrode to the last electrode with the usage of an automatic electronic system (Drahor, 2006). Because of the advantage of the technique, it was decided to apply ERT method in the investigation area to obtain information about the location, size and extension of the archaeological features. Additionally, measured apparent resistivities were inverted to true resistivities. The high resistive zones are thought to be man-made structures and were presented with 3D volumetric inverse resistivity model sections.

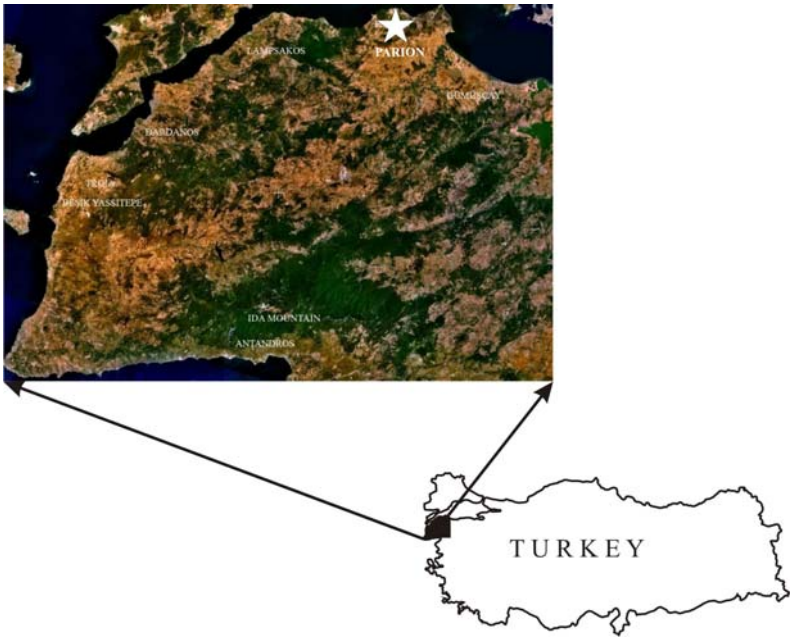

Figure-1. Ancient Troas region and location of the site of Parion.

FIELD MEASUREMENTS AND INTERPRETATION

ERT technique using the pole–dipole electrode array has been applied to Area2 in necropolis to obtain geo-electrical section of the subsurface. The dimension of the area is 23 m by 20 m. The measurements were made over 11 parallel lines, each 23 m long, and spaced 2 m apart from each other. The distance between stations was set 1 m. A total of 2057 apparent-resistivity values were obtained (n=1 to n=11). The apparent resistivity values were transformed into real resistivities of the subsoil. For 2D inversion of apparent resistivity data the algorithm proposed by Loke and Barker (1996) was used. Because the random noise of the field was generally less than 3% the maximum number of iteration was selected to be 4 or 5 for all profiles in order to avoid overfitting of the data. Data misfits (root-mean-square) were between 1.1 and 3.1. A MATLAB code was developed to present the result of 2D inversion of each profile jointly in a 3D volume. Then, following the data acquisition and inversion process, jointed presentation of 2D inversion results was obtained. This allows displaying the 3D volume in a range of user-selected orthogonal slices of bounding surfaces. Therefore, one can easily provide the representation of anomalous zones in all directions.

As can be seen from the Figure-2 and 3, the extension of the possible archaeological structures, which have high resistivity values, are clearly shown in these volumetric sections. The inversion results were also represented as horizontal depth slices in order to show high resistive zones in different depths where the archaeological structures were expected to be found (Figure-4). At the last step the high resistivity zones (>175 ohm-m) which are thought to be man-made structures were presented as isosurface sections. This presentation computes isosurface data from the volume data at the isosurface value specified in isovalue. That is, the isosurface connects points that have the specified value much the way contour lines connect points of equal elevation. By this way the 3D extension of possible burial remains can be clearly seen from with this visualization technique (Figure-5).

CONCLUSIONS

3D resistivity imaging survey was carried out at the ancient site of Parion. The aim of this study was to obtain some information about the location, size and extension of the possible archaeological features. The data along the 11 parallel lines were gathered and

each profile was inverted using 2D inversion schemes. The parallel geo-electrical sections were used to obtain volumetric representation, depth slices and isosurface sections. By this way the continuities of the anomalies of possible archaeological features in 3D was easily provided. The results show that the high resistivity values may indicate man-made features. These highest resistivity zones were suggested as the most promising locations for archaeological excavation.

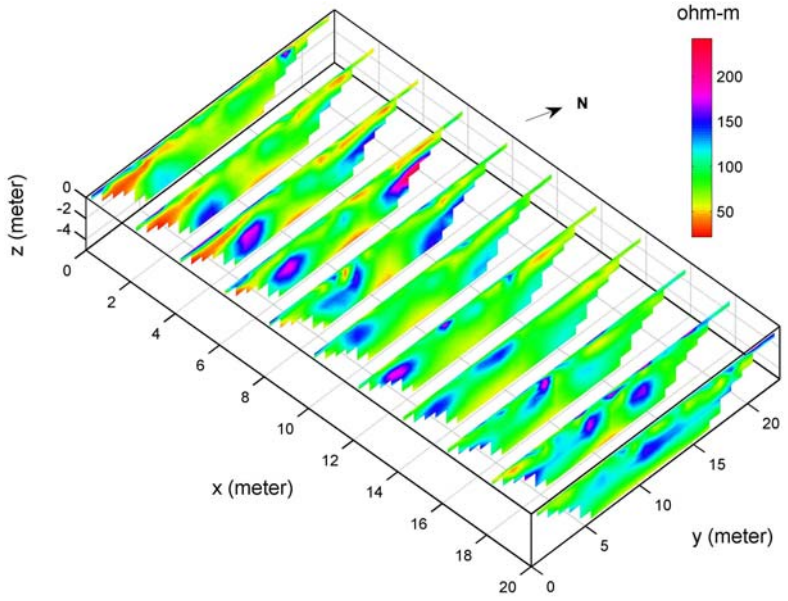

Figure-2. The 2D model resistivity sections of the 11 pole-dipole profiles

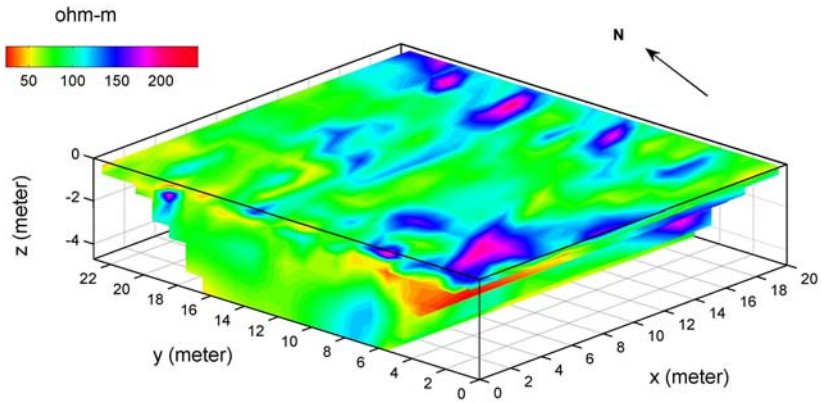

Figure-3. 3D resistivity imaging of the Area2 obtained from the inversion of 2D profiles

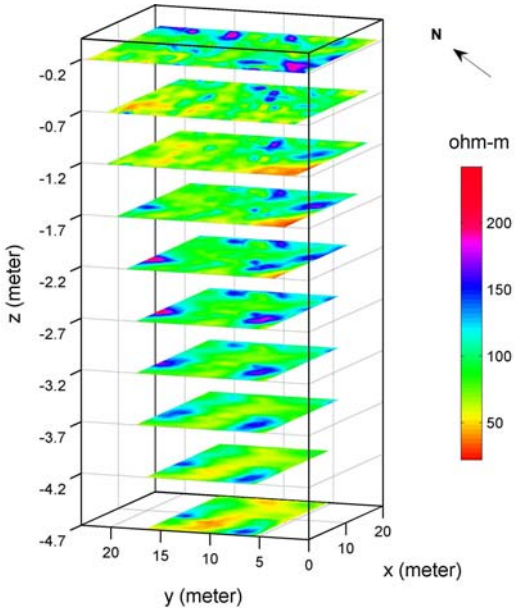

Figure-4. Horizontal depth slices of the resistivity distribution

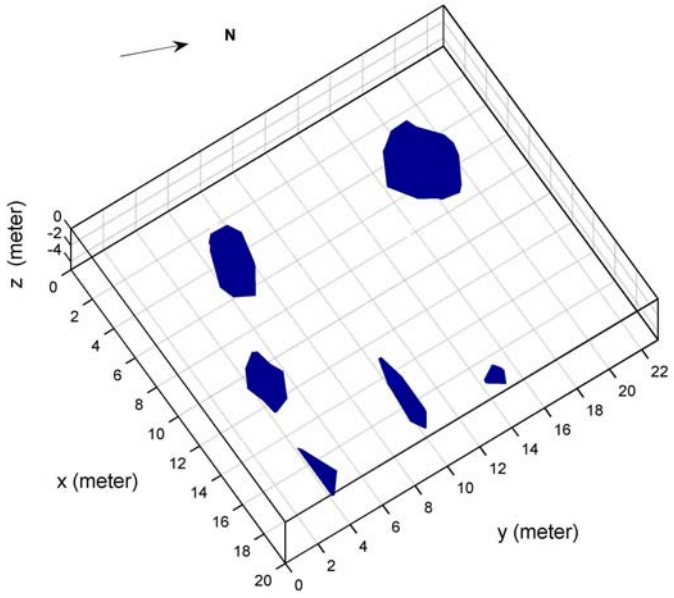

Figure-5. The isosurface section showing the extension of the possible burial features

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