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Geo-electrical characteristics of the Erecek-Çanakkale region

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Abstract

Biga Peninsula is one of the tectonically active regions in Northwestern Anatolia which the middle strand of the North Anatolian Fault Zone is crossed over by it. This work is aimed to model the subsurface geological structures via vertical electrical sounding (VES) and self-potential (SP) datasets collected from the relatively less known Southern part of the Biga Peninsula. The vertical electrical sounding (VES) and self-potential (SP) datasets collected near the Erecek village of Çanakkale city were inverted by the Levenberg-Marquardt algorithm. Four profiles were generated covering some VES points to reveal the geological model. In addition, resistivity distributions at 10, 100, 200, 500, and 1000 meter depth levels were calculated. Thus, the iso-3D resistivity distribution was easily observed. Based on the VES findings, three main geological units were defined; two groups of volcanic units and a metamorphic basement. Besides, WSW-ENE and NNE-SSW trending two normal faults that have possibly water content were observed. One of them was also detected from the self-potential profile data inversion results. As a result, possible main fault locations and tectonic structures that may be associated with groundwater containment have been described using the findings of both two geo-electrical methods.

Key words

Çanakkale, Erecek, Self-potential, Vertical Electrical Sounding

1. INTRODUCTION

Biga Peninsula is a tectonically active region on the Alpine-Himalayan Mountain Belt that corresponds to the northward movement of the Arabian plate and the northern part of the southern segment of the NAF zone lies on it [1]. The main fault systems of this region can be listed as Balabanli, Kestanbol, Tuzla, Evciler and Edremit Faults. Accordingly (bununla iliskili olarak), this region hosts (is also hosted) also several active geothermal areas such as Tuzla, Palamutova, Kestanbol, Kucukcetmi. Many geological and geophysical studies have been done to reveal the tectonic complexity of the peninsula[1]-[11]. Most of the previous geophysical investigations were seismological studies [12], [13] related with the Northern Anatolian Fault (NAF) kinematics and structural observations. The other geophysical methods such as gravity, magnetic and electrical methods were applied in the geothermal [14], landslide [15], and archaeological [16] investigations in the region.

Geoelectrical methods supply robust information about layer rock type, thickness, and water content [17], [18]. In this study, SP and VES field datasets (Figure 1 and Figure 2) collected from near the Canakkale-Erecek village were evaluated by inverse solution techniques. This area represents the transition zone between the Beydagi Horst and Tuzla Basin. Geological units of the study area are the Balabanli volcanics, Dededag formations, and Karadag metamorphics. The Balabanli volcanics consist of pyroclastic rocks such as rhyodacitic ignimbrites and lavas. The

Dededag formation contains andesitic and trachyandesitic lavas and flow-breccias. The Balabanli volcanics and Dededag formation lie over the metamorphic basement [3], [4], [8](Figure 2).

In this study, it is aimed to determine the electrical properties of an area located in northern part of Behram and western part of Erecek villages and combine with the possible tectonic features and accordingly possible geothermal potential. For this purpose, the VES and SP data were evaluated to distinguish main subsurface lithologies and location of the faults may associated with local groundwater movement.

2. METHODS AND APPLICATIONS

VES method employs an artificial source of current which is introduced into the ground through two electrodes. The occurred potential difference is measured at other electrodes. Electrical resistivity and depth of the layers can be calculated using Ohm Law. Electrical resistivity varies with porosity, pore fluid salinity, and clay content. On the other hand, SP method based on the measurement of potential difference between the two points on the earth surface without artificial current source. Source parameters of potential anomalies occurred by the mineralization, thermoelectric or electrochemical coupling processes could be estimated by SP measurements. Both geoelectrical methods are widely used in the determination of the subsurface structures, and faults.

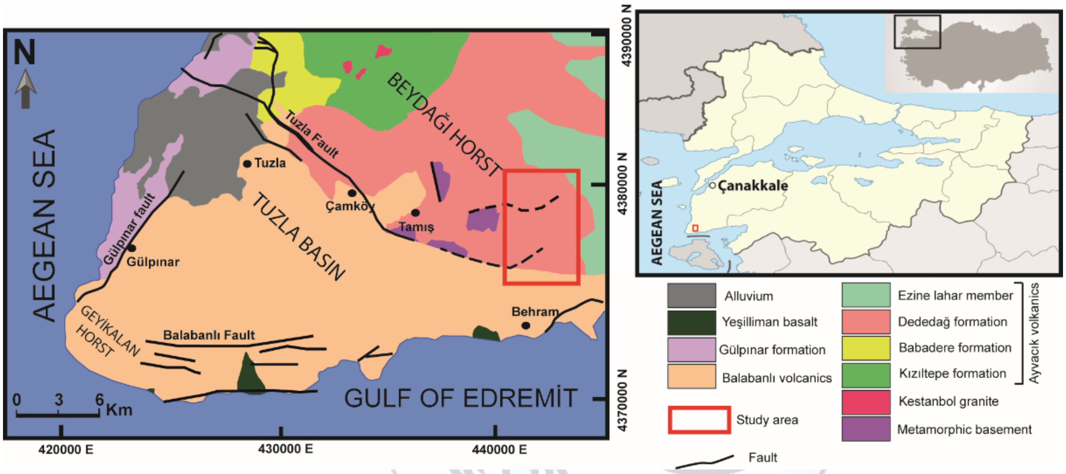

Figure 1. Geologic map of study area and surrounding (modified from [3])

In this study, investigation area is located between 26.3069N-263358N longitude and 39.5234E-39.5796E latitude and covers the area between the northern part of Behram and western part of Erecek villages of Çanakkale city (Figure 1). It is approximately spread over 30 km^2 area. The 43 vertical electrical soundings (Schlumberger array) and one SP profile data were evaluated by 1D inversion approach and four VES profiles (AA′, BB′, CC′ and DD′) were prepared for better interpret the geoelectrical model. AA′ and BB′ profiles are aligned in NNW-SSE, and CC′ and DD′ profiles are aligned in WSW-ENE direction. A self-potential profile (EE′) data was also aligned in WNW-ESE direction (Figure 2).

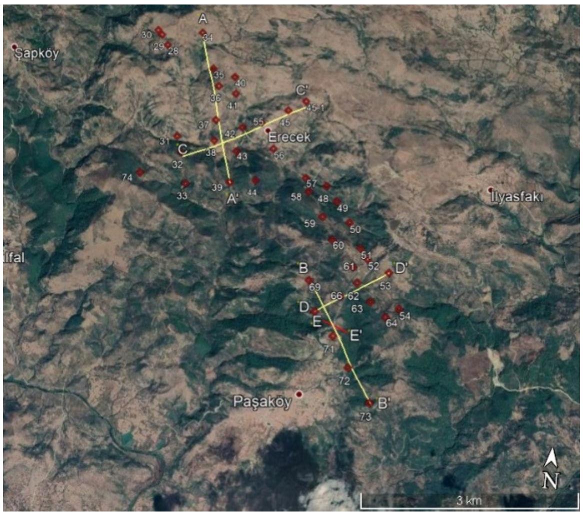

Figure 2. Location of VES points, VES and SP profiles

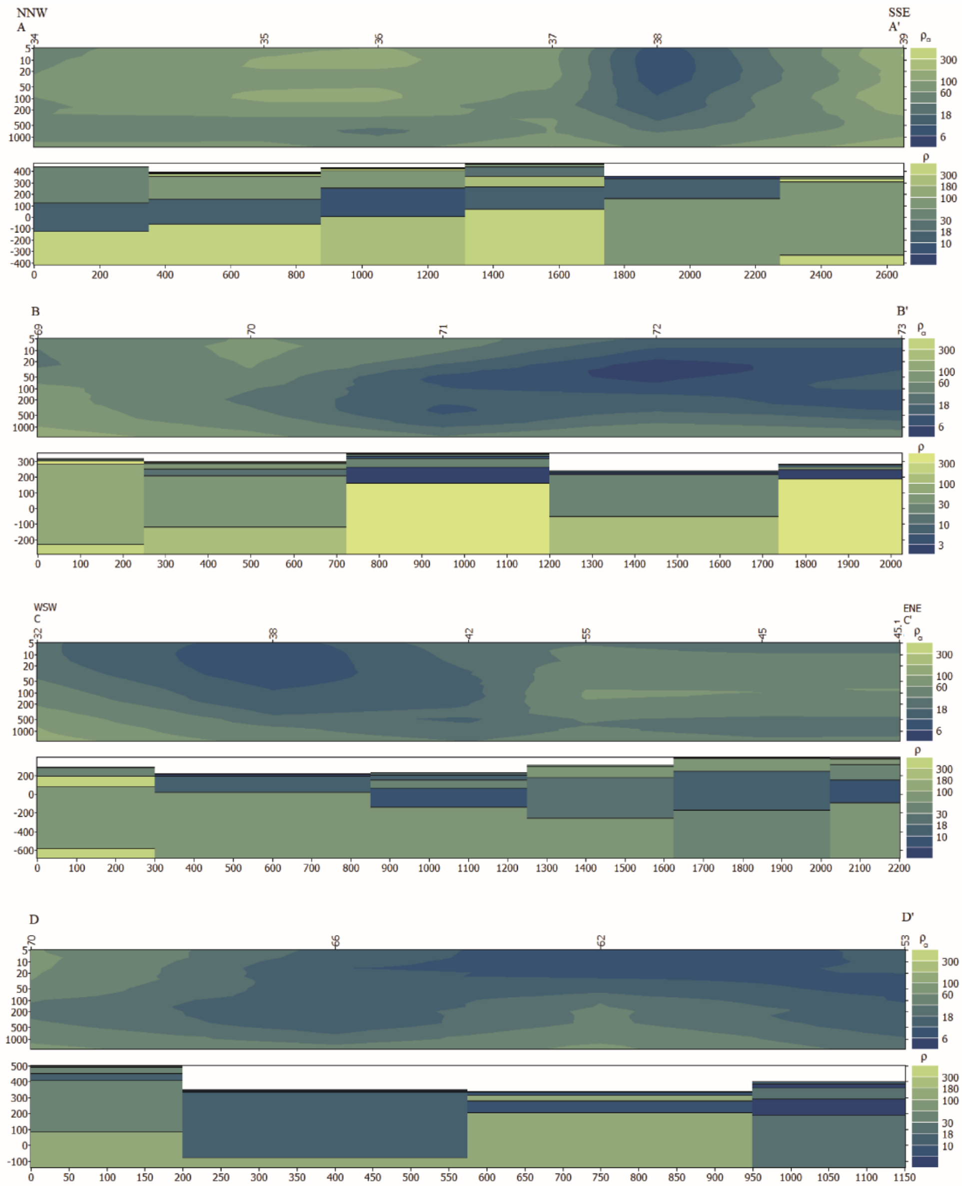

Figure 3. Pseudo and resistivity sections of AA′, BB′, CC′, and DD ′ VES profiles

The actual resistivity and thickness of the subsurface layers were obtained by inverse solution technique using the IPI2win software developed by the Geophysics Group Moscow State University [19]. (IPI2Win-1D Program, version 3.0.1a, 2003). The software realizes iterative minimization of the misfit between real and modelled data based on a least number of layers initial model using Tikhonov's approach. For all sounding curves inverted to obtain the actual resistivity and thickness of the subsurface layers. The fit between model response and the field data for the VES points were generally lower than 5%. In addition, pseudo and resistivity sections of four profiles were created by combining some selected points from them (Figure 3). According to the parameters of these sections geological models were established (Figure 4). Then, apparent resistivity distributions for many depth levels (10, 100, 200, 500, and 1000 meter) are plotted to reveal the areal resistivity distribution versus to depth (Figure 5).

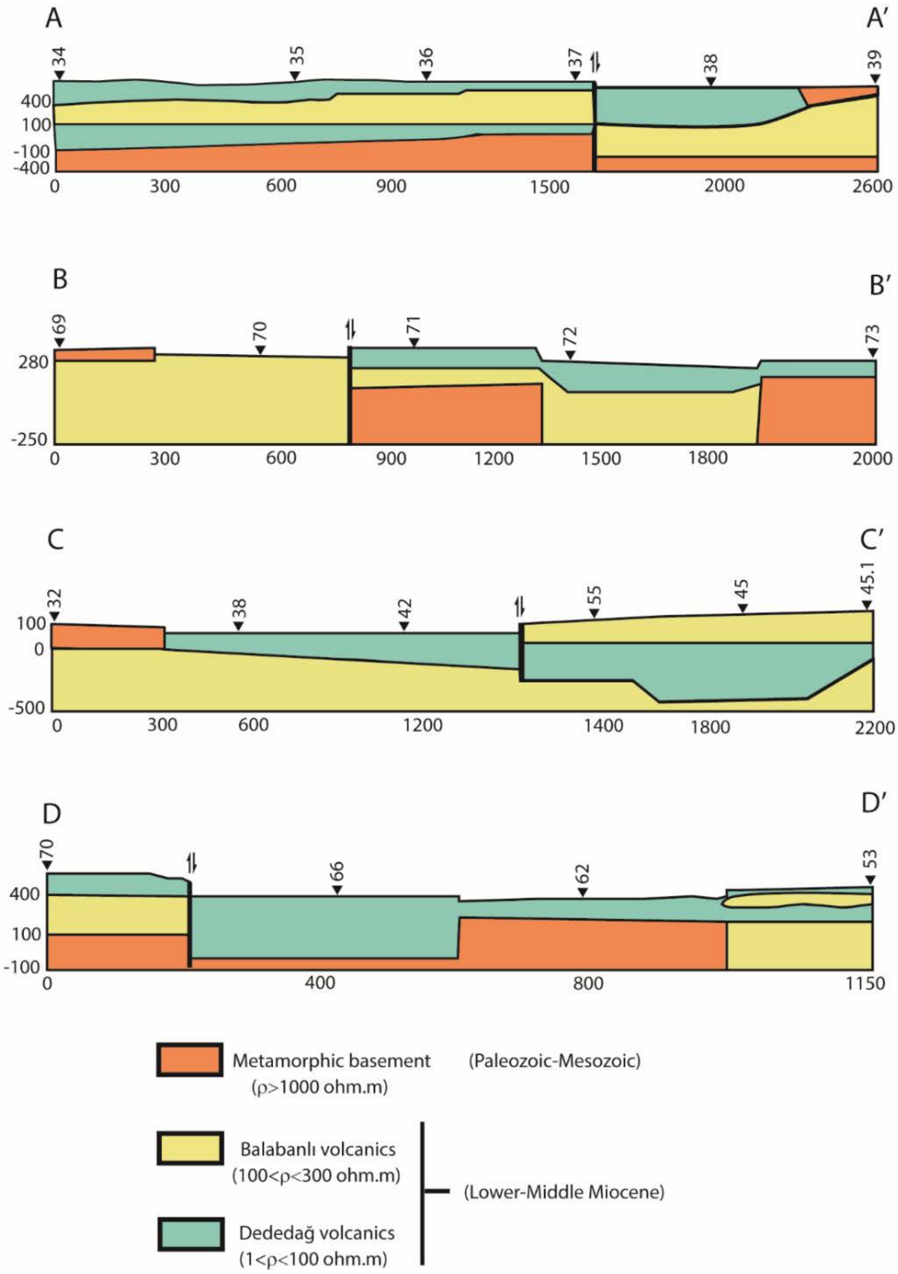

Figure 4. Geological models of VES profiles

The SP profile data (EE′) were evaluated by Levenberg-Marquardt (LM) inversion algorithm [20]. Profile data were assumed produced by a simple sphere-shaped polarized causative body. Parameters of sphere model are electric dipole moment (K), horizontal distance (x), distance from the origin (x_0), depth to the centre of the body (z_0), and polarization angle (θ). The polarization angle is determined as the angle between vertical plane and polarization surface. Calculated SP parameters are shown in figure 6 and Table 1.The root mean standard error is 0.1155.

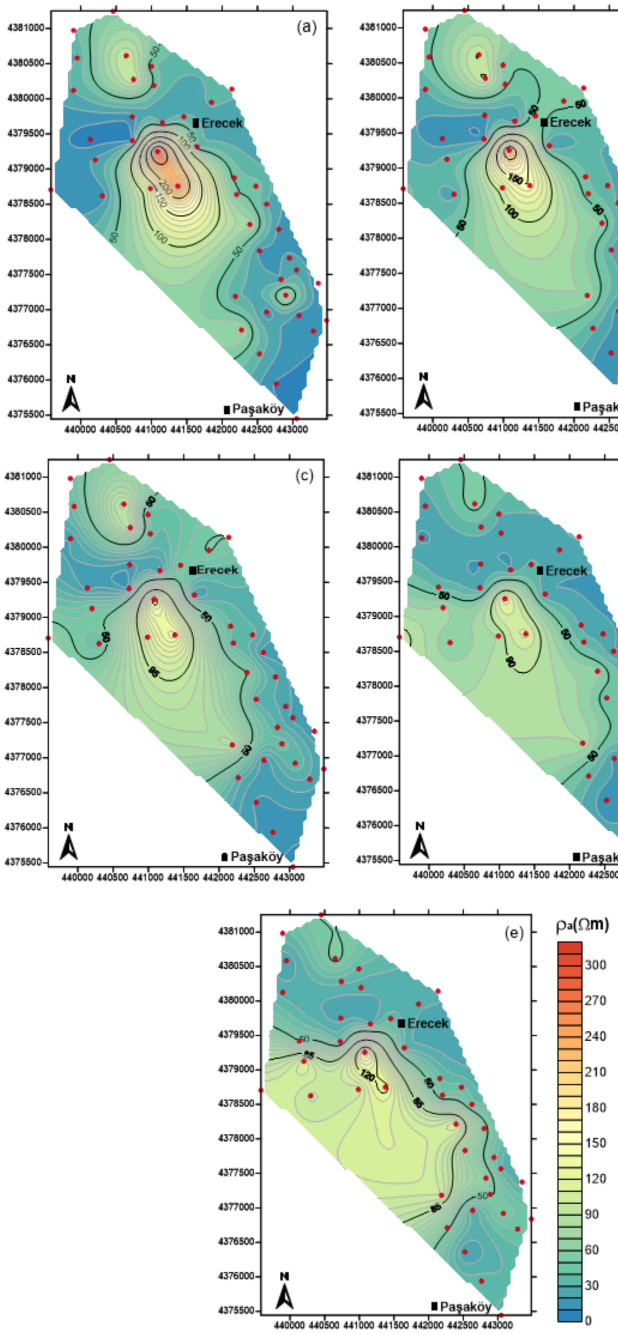

Figure 5. Contour maps of the iso-apparent resistivity values (a) AB/2=10m, (b) AB/2=100m (c) AB/2=200m,(d) AB/2=500m, (e) AB/2=1000m

Table 1. Calculated SP model parameters

E. dipol moment (K)	Polarization angle (θ)(°)	Distance from the origin (x_0)(m)	Depth (z_0) (m)
447432.17	1.37	216.88	145.38

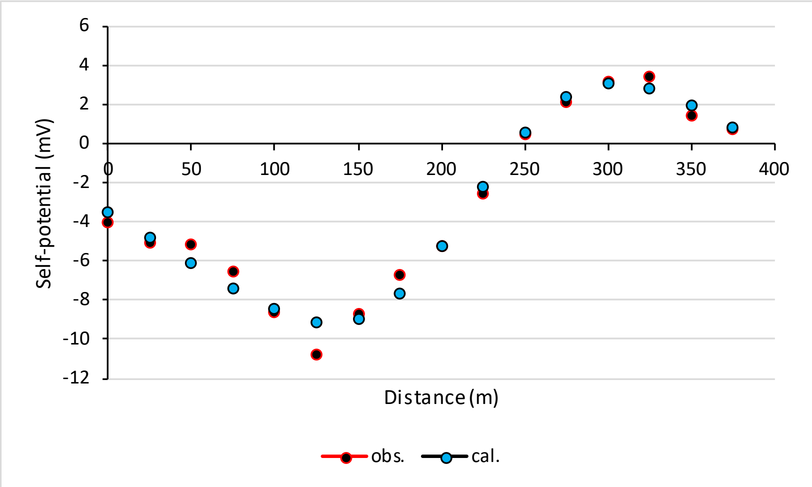

Figure 6. Observed and calculated SP values

3. RESULTS AND CONCLUSIONS

In this study, VES and SP methods were applied to distinguish main subsurface lithologies and locate faults that may be associated with local groundwater movement. As a result of the 1D inversion of VES, three main distinct units have been identified. The first one is the Dededag surface volcanics characterized by low and medium resistivities (1-100 ohm.m), the second one is the Balabanli volcanics having medium resistivities (100-300 ohm.m) and the third one is the metamorphic units (having resistivities higher than 1000 ohm.m) forming the basement. These geological formations were also described in the four VES profiles (AA′, BB′, CC′ and DD′). It has been revealed that the surface volcanics become thinner and the metamorphic basement units reach to the surface near the VES 32, 38 and 69. Not only from the cross-sections but also the depth level maps it is seen that the high resistive basement spread out over the area between the southwestern part of Erecek and the northern part of Pasakoy villages. WSWENE and NNE-SSW trending two normal faults that have possibly water content were observed. One of them was also detected from the self-potential profile data inversion results. The calculated polarization angle shows that the fault has a slope close to the vertical. The x0 parameter corresponds to the distance between location E and the intersection of BB′ and EE′ profiles in the figure 2. Since the location of fault determined as between VES 70 and 71 points at BB′ profile, it well matches the x0 determined by SP inversion. Although these parameters were obtained from only one SP profile dataset, determined fault location is very similar to the results of resistivity inversion. It is observed the areas that have resistivity values below 10 ohm.m matched the alignment of the detected two faults. These areas may have contains hot or cold groundwater. Therefore, it is recommended to search geothermal potential of these areas by other hydrogeophysical and hydrogeological methods.

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CONFLICT OF INTEREST STATEMENT

The author declare that there is no conflict of interest.

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