# INVESTIGATION OF BURSA, ESKIKARAAGAC USING VERTICAL ELECTRICAL SOUNDING METHOD

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**Abstract:** The aim of this research is to study the ground resistivity of a region located at Bursa, Eskikaraağaç village by using vertical electrical resistivity (VES) method which is one of the geoelectrical methods. For that purpose, two Wenner arrays were applied on the ground. The measured VES data is analyzed via software named RES2DINV. The program gives layer thicknesses and real resistivity values on two dimensional underground resistivity sections. Interpretations on the possible locations of water can also be made. These interpretations can later be verified by drilling groundwater wells.

**Keywords:** Vertical Electrical Sounding, RES2DINV, Wenner array

## Introduction

Today, climate change leads to shortage of water while the demand from limited resources increases with population. Drilling is unknowingly used for the purpose of searching and finding water. Whereas, geoelectrical methods provides some information about aquifer layers and water existence before drilling. Geoelectrical methods are the most common methods in exploration geophysics. The method, which makes use of the resistivity feature of earth, is used in search for underground assets such as water, geothermal energy, minerals and petrol.

In this study, geophysics resistivity measurements have been conducted on a previously chosen field over the aquifer at Eskikaraağaç village. Resistivity measurement was taken using Wenner arrays. Two pieces of Wenner arrays were made in total. A program called RES2DINV (Loke, 2000) was used in the evaluation of these measurements. Consequently, real resistivity values and thicknesses of geological layers were obtained and mapped in two dimensions. By considering real resistivity values and the two-dimensional map, inference about water existence was made.

## Geoelectrical Methods

Basically, geoelectrical methods are implemented in three different ways. These are Self Potential (SP), Induced Polarization (IP) and Vertical Electrical Sounding (VES). Vertical electrical sounding method is based on the principle of measuring the potential difference formed by electric current delivered to the ground by two current electrodes. The aim of this method is to determine the depth and resistivity of underground layers by using surface potential measurements. VES method has different geometrical arrays depending on the problem on the ground. The most common used arrays are Schlumberger, Wenner and Dipol-Dipol. Basic differences between arrays are investigation depth and horizontal solution accuracy. Comparing Wenner and Schlumberger; both electrode arrays have the same current transmission horizontally, however, investigation depth is more in Schlumberger method. For the same opening width, accuracy of measurement is much better in Wenner array. According to these comparisons; generally, Wenner is preferred for shallow studies. As to Schlumberger, it can be used both shallow and deep research (Başokur, 2004). In Figure 1, A and B are current, M and N are potential electrodes in a Wenner array. In practice, electrode current is emitted from two points like A and B and then potential difference is measured from separate two points like M and N.

  

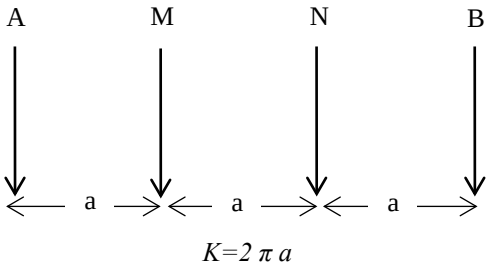


**Figure 1**. Wenner array

After calculating the geometric factor (K), apparent resistivity is calculated with Eq. 1.

$$\rho = \left(\frac{\Delta V}{I}\right) K \qquad (1)$$

ρ= Apparent resistivity (ohm-m)

ΔV= Voltage (mV)

I= Current (mA)

K= Geometric factor

Essentially, earth consists of complex structures rather than isotropic semi-infinite media. Because of this reason, resistivity relationships do not give real ground resistivity values. Resistivity value obtained with current given into the ground and obtained using several equations is named as apparent resistivity. Apparent resistivity is equivalent to real resistivity in case of isotropic semi-infinite media (Başokur, 2004). To obtain real resistivity of layers and thickness of layers graphical methods are used. Generally, on a logarithmic paper, apparent resistivity value is placed on vertical axis and electrode spacing on horizontal axis and several methods are used to obtain value of real resistivity and thickness of layers. These methods are given below;

a. Successive approximation methods

b. Asymptotic estimate

c. Rough estimate methods

d. Estimate with model curves

d.1. Estimate with double layer model curves

d.2. Estimate with three layer model curves

d.3. Estimate with assistance point cards

e. Direct comment methods

While Successive approximation methods have been the least used methods, Asymptotic estimate were the most used methods until computers improved (Coşkun, 2005). Programs, such as IPI2WIN (Bobachow, 2002), RES2DINV (Loke, 1997) are widely used today.

  

## Field Study

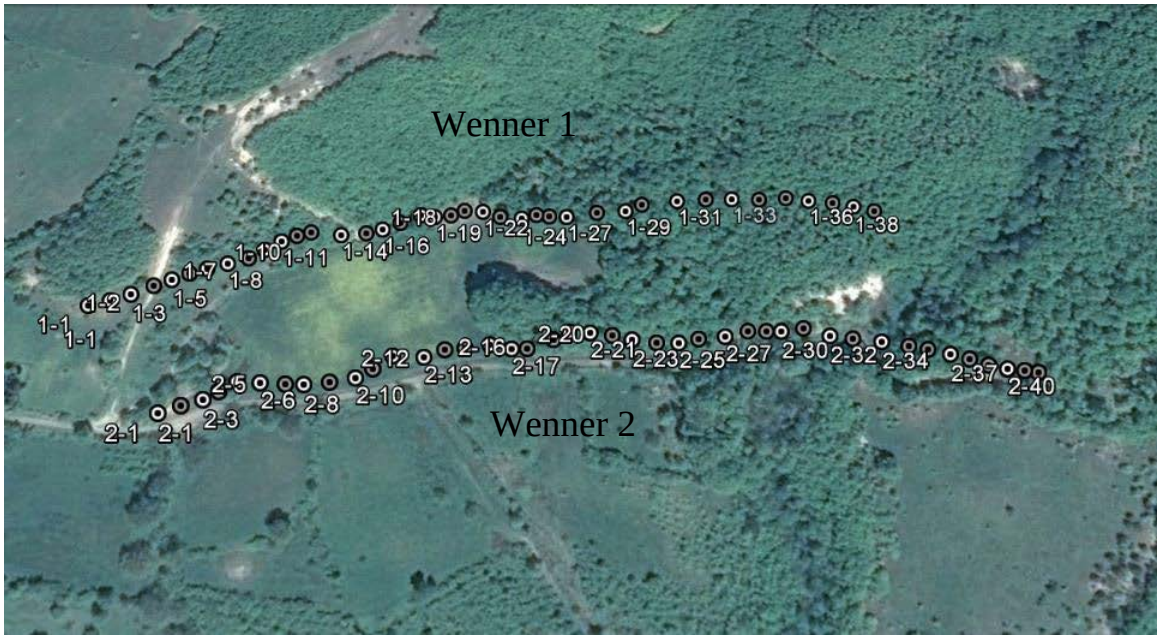


**Figure 2.** Measuring points

Wenner arrays (Multiple-electrode resistivity method) is implemented in two profiles (Figures 2-3-4). 39 electrodes were used, electrode spacing was selected as 10 meters. Totally, 380 meters of opening is made for Wenner 1. 42 electrodes were used, electrode spacing was selected as 10 meters. Totally, 410 meters of opening is made for Wenner 2.

**Figure 3**. Wenner 1

  

**Figure 4.** Wenner 2

## RES2DINV's Results

After records taken from multichannel resistivity device were transferred to a computer in DAT format, they were evaluated by RES2DINV program for the two Wenner arrays (Figure 5 and Figure 6). In the evaluation, real resistivity, layer thicknesses and also possible well location were obtained. Formations are indicated in Figure 5 and Figure 6. Alluvial formations are available in different regions in Figure 5, Figure 6. For this reasons possible well location is chosen at x=85 m along Wenner 1 array.

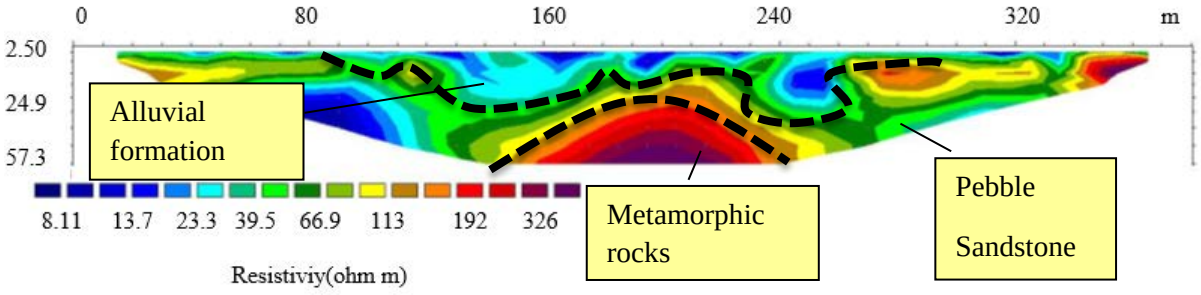


**Figure 5.** RES2DINV's results for Wenner 1 array

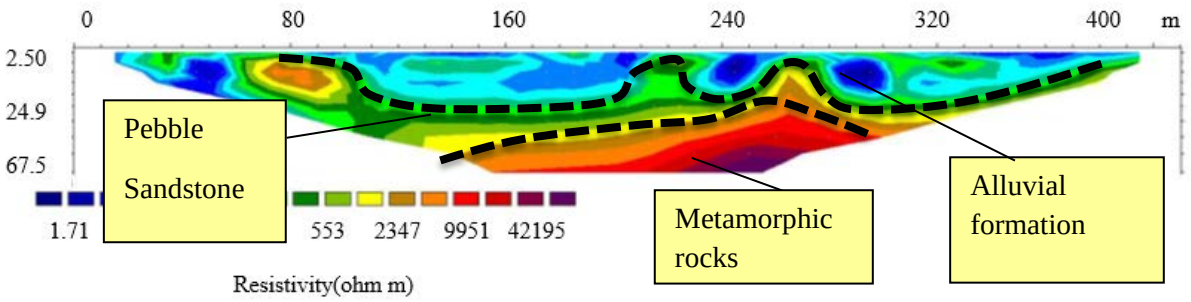


**Figure 6.** RES2DINV's results for Wenner 2 array

  

## Conclusion

Considering the two-dimensional maps in Figure 5 and Figure 6, when resistivity values are small, water containing formations are thought to be available. If the location is indicated with blue color, it may be alluvial formation. If the location is indicated with yellow or green colors, it may be pebble, sandstone. Dark red unit is considered to be the metamorphic rocks.

By referring to the two-dimensional maps, comments can be made about the location of the well to be drilled. While determining the location of a well, it is necessary to consider drilling method and formation. The suggested well location in this study lies along Wenner 1 line at around x=85 m which is located away from alluvial formations. Mud rotary drilling method is preferred for suggested well. The reason for this method is that it is more economical than others.

## References

Başokur, A.T. (2004), Düşey Elektrik Sondajı Verilerinin Yorumu. Ankara Üniversitesi Mühendislik Fakültesi, 225 s.

Bobachow, A. (2002), "Ipi2win user's guide." Moscow State University.

Coşkun, A. (2005), Yeraltısu Kaynaklarının Terrameter Sas 300C Cihazı ile Tespiti. Yüksek Lisans Tezi, Fırat Üniversitesi, Yapı Eğitimi Anabilim Dalı, Elazığ.

Loke, M. H. (1997), "Res2DINV software user's manual." University Sains Malaysia, Penang.

Loke, M. H. (2000), Electrical Imaging Surveys for Environmental and Engineering Studies, a Practical Guide to 2- D and 3-D Surveys: Manual of RES2DINV and RES3DINV software.

  