# SURFACE GEOELECTRIC SOUNDING FOR THE DETERMINATION OF AQUIFER CHARACTERISTICS IN ABOH AND ENVIRONS DELTA STATE

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**ABSTRACT**
Vertical electrical sounding data were acquired from 10 locations evenly spread within Aboh town and environs. Interpretations of the data reveale that two layers of near surface aquifer were identified in Aboh and environs. The first layer is shallow, but the filling of the pore spaces with overlying fine-grained and clayey sand formation have reduced the efficiency of this layer.
The second layer is the best and of very good quantity of groundwater. It is therefore recommended that boreholes for sustainable water supply should be drilled to a depth of between 40.00 m – 55.00 m within Aboh and environs. This value should not be exceeded at Okpai-Oluchi because of the confining bed or brackish water formation in the fifth geoelectric layer. Furthermore, apart from Okpai-Oluchi that seems to have a confining bed below the second aquifer, the aquifer in Aboh, Igbuku, Okpai-Oluchi and Beneku are semi-confined or leaky while Ashaka has an unconfined aquifer. Appreciable quantity of groundwater could be obtained in Ashaka followed by Beneku, Igbuku, Okpai-Oluchi and Aboh in a Descending order. The low values of the root mean square 1.4% - 2.6% signify the accuracy of the data obtained from the field. The VES interpretation correlates well with the information obtained from borehole litho logic log.

**Keyword**: *Vertical electrical sounding, groundwater potential, aquifer,Aboh,Ashaka, Beneku, Igbuku, Okpai, Drillers log and Geoelectric Section.*

## 1. INTRODUCTION

Water is of fundamental importance to plants and animals particularly man. It is then very vital in maintaining life processes and growth (Ogbe, 2003). Potable (drinking) water is not commonly found and its provision limits the setting up of villages and towns to the places where supply exist (Shankar, 1994 and Huisman, 1966). In Aboh and environs, the residence depend on the slow running water from river Niger and its tributaries such as Ase creak and hand dug wells for their domestic water needs but today, increased activities within the study area which includes gas flaring at Kwale/Okpai gas plant, dead and decayed organic matter in contact with the rivers, streams and lakes, the drilling activities and the effect of buried pipes (rust) as well as the numerous oil spillages especially that of August 2002 in River Niger, the Ashaka 1 location spills of 1978 and 1983 respectively and the recent fire and oil spillage at Abalagada in have drastically polluted the source of water supply to the region and rendered it unhygienic and unsafe for drinking (Oseji et al, 2005). Unfortunately, these were the only available source of water, despite the increased demand for potable water in the region due to increase in the population within the last few years.
A better knowledge of the near surface aquifer distribution, formation and type in this area is therefore important so as to ascertain whether the aquifer is prone to contamination or not since the surface water have been polluted. ( Oseji et al 2006). Most of the side effects of oil production are the possible pollution of water and the destruction of aquatic lives.

Water pollution occurs when rainwater combines with the by-products of gas flaring in the atmosphere, (Ebeniro et al 1996). In most cases, air oxides such as nitrogen and sulphur become acidic contaminant during rainfall and the water flows into surface water that has been further polluted as a result of decaying organic matter. Some of the water on the land surface infiltrates underground and becomes groundwater, one of our most valuable natural resources.

In fact, most freshwater on earth exists beneath the land and its geologic occurrence is the subject of many misconceptions. In the past, it was believed that groundwater occurs as large lakes or pools beneath the land. According to Bernard et al, 1994 groundwater occurs in pore spaces and fractures within sedimentary rocks.
Underground Water sustains and maintains stream flow when it is close to the surface, but where it intersects the surface, a spring or watering hole is formed. Okolie et al, (2005) carried out the determination of the source of River Ethiope in Delta State of Nigeria.

Groundwater therefore, is that which exist below the earth surface, within saturated layers of sand, gravel and pore-spaces in sedimentary or crystalline rocks, while freshwater is the water from the zone that is not invaded. (Tyson, 1993).

When more rainfall occurs, the solute penetrates the soil deeper and this percolates the water table. During percolation, the water leaches the buried pipes, waste materials from the gas plant, Industries, Factories and washes down the spilled oil into the soil thereby becoming part of the flow system immediately it gets to the water table. (Oseji et al 2005; Oyedele, 2001 and Wilson, 1990). In areas of shallow water table, the buried drilling pipes are in direct contact with groundwater; this produces maximum potential for groundwater contamination if the soil is permeable.

Groundwater is highly purified by straining actions of the rocks as the water percolates through it; however, soluble impurities are not easily removed from water, even though there is the possibility of ion exchange reaction in them. Thus pollution occurs by the seepage of pollutants through the soil and by contaminants migration from the surface of the earth. The use of soak away and industrial effluents may impair groundwater quality, unless there is an impermeable stratum between the disposal and groundwater table.

These processes may impair with water from the rivers, stream, hand dug wells and boreholes and render it unhygienic and unsafe for drinking. This could lead to, in most cases, outbreak of diseases and serious health hazard to the users. Hence the need for an Environmental Geophysical survey cannot be overemphasized in getting background information on the distribution, formation and type of the near surface aquifer in groundwater development, as a means of knowing the areas that may be prone to groundwater contamination and determine the locations were sustainable and potable water supply could be achieved. The vertical electrical method was chosen for this study because the instrumentation is simple; field logistics are easy and straightforward and the analysis of data is less tedious and economical (Zohdy 1974; Zhody et al 1974 and 1993; Ujuanbi et al 2005; Ekine and Osobonye 1996; Ako and Olorunfemi 1989; Overneeren 1989; Etu Akpokodge 1990; Etu-Efeotor et al 1989; Okolie et al 2005; Freeze and Cherry 1997; Osemeikhian and Asokhia 1994).

## 2. FIELD PROCEDURES

Two major stages of field procedures were used in this research. Vertical electrical sounding data were acquired from 10 locations evenly spread within Aboh town and environs. Interpretation of data were done quantitatively and qualitatively and bringing in to bear the knowledge of the local geology of Aboh.

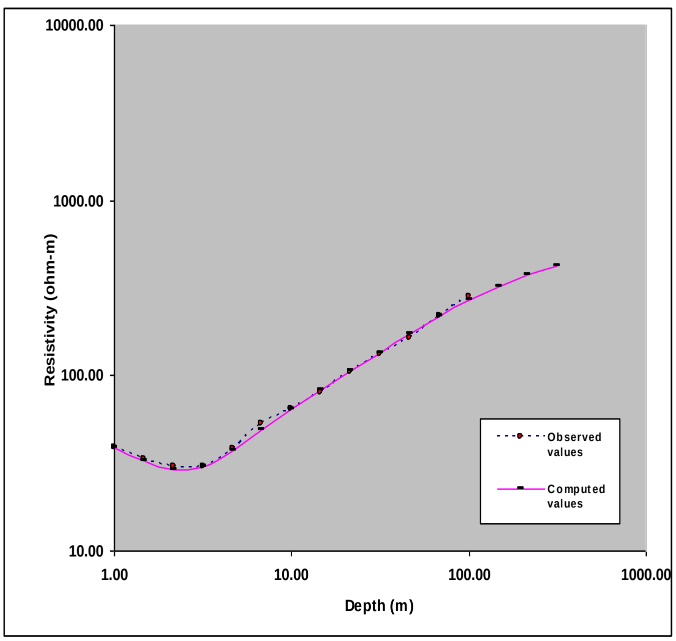


Figure 1: Resistivity Sounding Interpretation for VES 1(Aboh) Showing Observed (Field) and Computed Resistivity Data and Curves; and Interpreted layer model Parameters

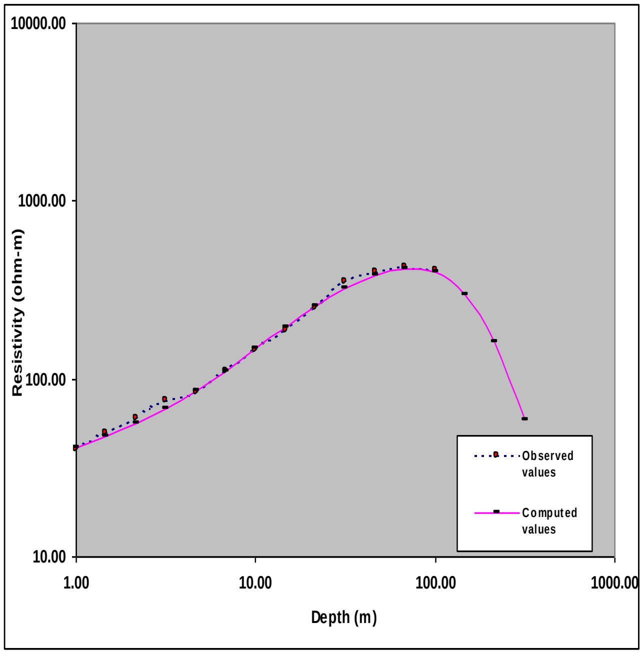


Figure 2: Resistivity Sounding Interpretation for VES 2 (Okpai-Oluchi) Showing Observed (Field) and Computed Resistivity Data and Curves; and Interpreted layer model Parameters.

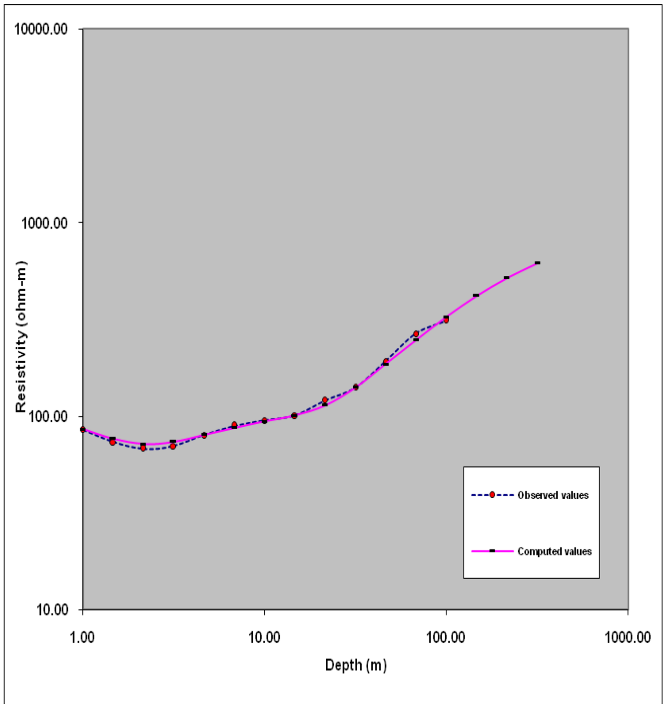


Figure 3: Resistivity Sounding Interpretation for VES 3 (Igbuku) Showing Observed (Field) and Computed Resistivity Data and Curves; and Interpreted layer model Parameters.

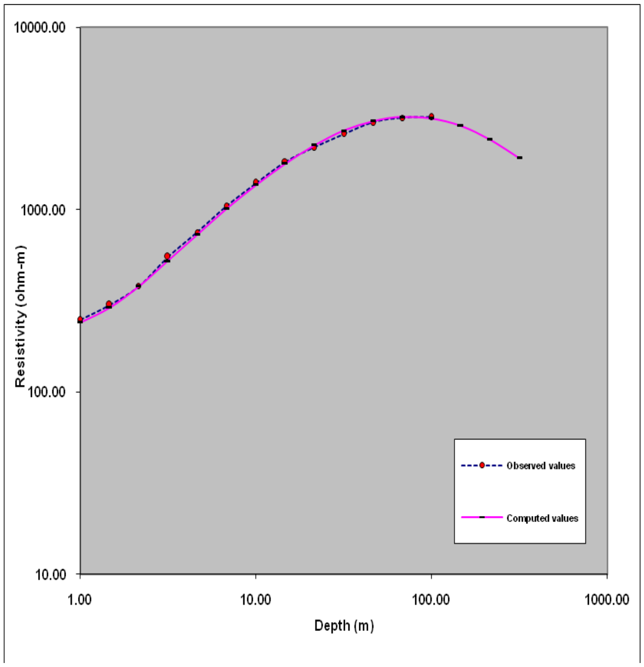


Figure 4: Resistivity Sounding Interpretation for VES 4 (Ashaka) Showing Observed (Field) and Computed Resistivity Data and Curves; and Interpreted layer model Parameters.

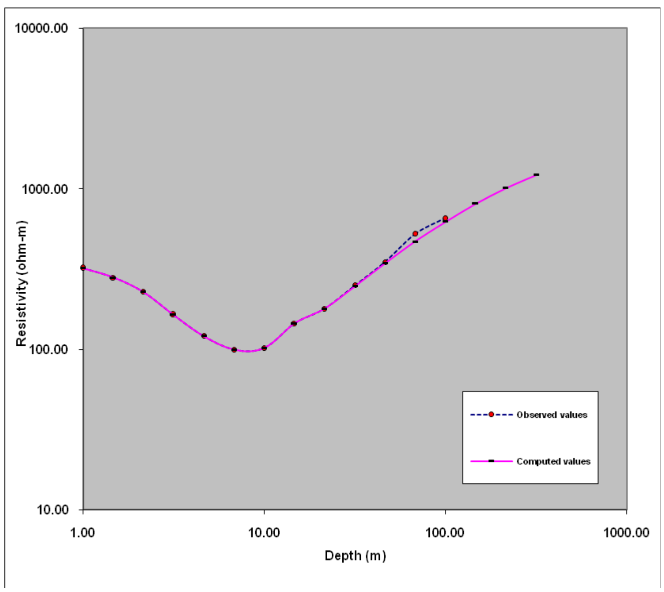


Figure 5: Resistivity Sounding Interpretation for VES 5 (Beneku) Showing Observed (Field) and Theoretical Resistivity Data and Curves; and Interpreted layer model Parameters.

## 3. RESULTS AND DISCUSSIONS

Geologically, Aboh, Okpai-Oluchi, and Igbuku areas are within the meander belts of the Niger Delta Basin, while Ashaka and Beneku is in the Sombriero Warri deltaic plain deposit invaded by mangrove and the wooded back/fresh water swamps respectively. The curve types are HAA for Aboh and Igbuku, HA for Beneku, AK for Ashaka and AAK for Okpai-Oluchi,

The interpreted sounding curves from the locations at Aboh, Okpai-Oluchi, Igbuku, Ashaka and Beneku shown in figures 1, 2, 3, 4 and 5 generally revealed 3 – 5 geoelectric layers as shown in figure 6.

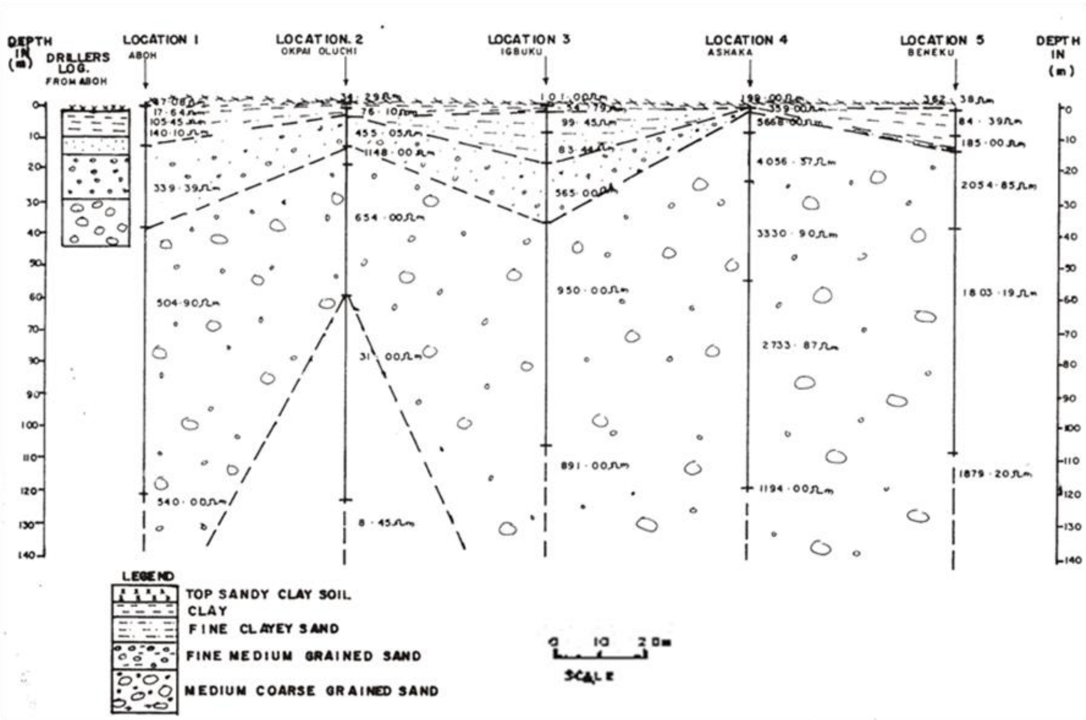


Figure 6: Geoelectric Section of Aboh Town and Environs

The lithologic information from producing borehole at Aboh was used in conjunction with the knowledge of the local geology of the area in constructing an earth model. The lithologic log indicates broadly that within the depth penetrated, the lithologic successions are the top sandy clay formation, clay sand, fine grained sand, medium grained sand and coarse grained sand respectively.

The first and the second geoelectric layers correspond to the topsoil with resistivity values ranging from 17.00 $\Omega$m - 100.00 $\Omega$m. This reflects clay to fine sandy clay and clayey sand formations. The high resistivity values obtained in the topsoil of Beneku and Ashaka is due to the compactness and dried nature of the topsoil. The thickness of this layer varies from 0.80 m – 15.00 m. Though the sand in this layer contains water, it is not a good aquifer. The thickness of the clay layer is about 0.78 m, which is not thick enough to act as a confining bed. However, in the event of pollution, groundwater is easily contaminated at Ashaka than in any other locations within Aboh and environs.

The third geoelectric layer consists of fine-grain to medium-grained sand. This is the first aquifer. It is a shallow aquifer whose efficiency may be reduced by the filling of the pore spaces with fine-grain sand formation. It has a thickness that varies from 0.60 m – 25.00 m at a depth of between 1.00 m and 15.00 m. The resistivity ranged from 300.00 $\Omega$m – 500.00 $\Omega$m. This aquifer is very thin at Ashaka and has been compressed in Beneku.

The fourth geoelectric layer consists of medium-grain to coarse-grained sand. This is the best aquifer of very good quantity of groundwater for sustainable water supply. It is the second aquifer with resistivity values ranging from 500.00 $\Omega$m – 3000.00 $\Omega$m at an average depth of 15.00 m – 40.00 m. It is the last layer with an undefined thickness except at Okpai-Oluchi that has a clay formation or brackish water below this layer with resistivity values of between 8.00 $\Omega$m – 30.00 $\Omega$m.

It should be noted that boreholes for sustainable water supply must not exceed a depth of between 40.00 m – 55.00 m at Okpai-Oluchi because of the confining bed in the fifth geoelectric layer.

From the above analysis, two near surface aquifers have been identified in Aboh and environs. The first aquifer is shallow, but the filling of the pore spaces with overlying fine-grained and clayey sand formations must have reduced the efficiency of this aquifer.

The second aquifer is the best and of very good quantity of groundwater. It is therefore recommended that boreholes for sustainable water supply should be drilled to a depth of between 40.00 m – 55.00 m within Aboh and environs.

This value should not be exceeded at Okpai-Oluchi because of the confining bed or brackish water formation in the fifth geoelectric layer.
Furthermore, apart from Okpai-Oluchi that seems to have a confining bed below the second aquifer, the aquifers in Aboh, Igbuku, Okpai-Oluchi and Beneku are semi-confined or leaky while Ashaka has an unconfined aquifer. Appreciable quantity of groundwater could be obtained in Ashaka followed by Beneku, Igbuku, Okpai-Oluchi and Aboh in a Descending order.
The low values of the root mean square 1.4% - 2.6%) signify the accuracy of the data obtained from the field. The VES interpreted correlates well with the information obtained from borehole lithologic log obtained at Aboh.

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