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Groundwater Potential of Ekiti State University Research Farm, Ado Ekiti, Southwestern Nigeria

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Abstract: ***Ekiti State University is an academic environment with an increasing need for steady and sustainable water supply. This study aimed at locating aquiferous zones where groundwater can be exploited. The objectives are to delineate the groundwater potentials; and determine the layer resitivities and lateral extent. A geophysical investigation technique involving the vertical electrical sounding (VES) was employed to provide information about the subsurface condition with respect to depth. Four (4) VES points' data were acquired. The results of the interpretation was predominated by a KH-Type curve, delineating four (4) layers. The layers were topsoil, sandy clay, weathered/fractured layer and the crystalline basement based on their resistivity values. The topsoil had resistivities ranging from 75.7 Ωm- 449.8 Ωm to a depth of 0.9 m-2.9 m. The second layer characterized by sandy clay had resistivities ranging from 628.6 Ωm- 700.9 Ωm to a depth of 3.7 m-15.1 m. The weathered layer had resistivities ranging from 37.7 Ωm- 195.4 Ωm to a depth of 14.1 m- 32.7 m and the fresh bedrock had resistivities ranging from 2430.7 Ωm- ∞. The results reveal thick overburden (about 3m to 15m) which aquiferous. The weathered/fractured layers in VES 1, 2 and 4 have anomously low resistivity values and therefore, are assumed to be the zones where appreciable amount of water can be found.***

Keywords: Aquiferous, Groundwater, Technique, Basement, Potential

1. Introduction

Groundwater is the water that occurs in a saturated zone of variable thickness and depth below the earth's surface. The primary source of groundwater is rain and snow that falls to the ground, a portion of this precipitation infiltrates and percolates down into the ground to become groundwater. Groundwater is therefore the water beneath the earth's surface from which wells, springs, and groundwater run-off are supplied. Groundwater potential is measured by;

a) The recharge rate and mechanism,
b) Aquifer storage and transmission properties,
c) Suitability of the water from water quality point of view, and
d) The response of the aquifer to changes such as climate, seasonality, artificial withdraw and pollution.

The hydro-geological features such as sub-soil structure, rock formation, lithology and location of water play a crucial role in determining the potential of water storage in groundwater reservoirs.(Carruthers, 1985; Emenike, 2001). To assess the groundwater potential, a suitable and accurate technique is required for a meaningful and objective analysis. A critical study is carried out on the different methods of estimating the groundwater potential and arrived at the most suitable technique for practical utility. Groundwater is an integral phase of the concept of hydrological cycle (Figure 1) which explains the endless circulation of water between ocean, atmosphere and land. Inflow to the hydrological system arrives as precipitation in the form of rainfall or snow melt. Outflow takes place as stream flow (run off) and as evapotranspiration from the soil. Precipitation is delivered to stream (surface runoffs) both on land, surface and overland or tributary channels and by sub-surface flow routes, as interflow and base-flow following infiltration into the groundwater for several yearswithin the aquifer units.

The resistivity method is the most effective for locating productive well and the Vertical Electrical Sounding (VES) technique can provide information on the vertical variation in the resistivity of the ground with depth and the Constant Separation Traversing (CST) provides a means of determining interval variation in the resistivity of the ground (Olayinka and Mbachi, 1992; Olorunniwo and Olorunfemi, 1987).

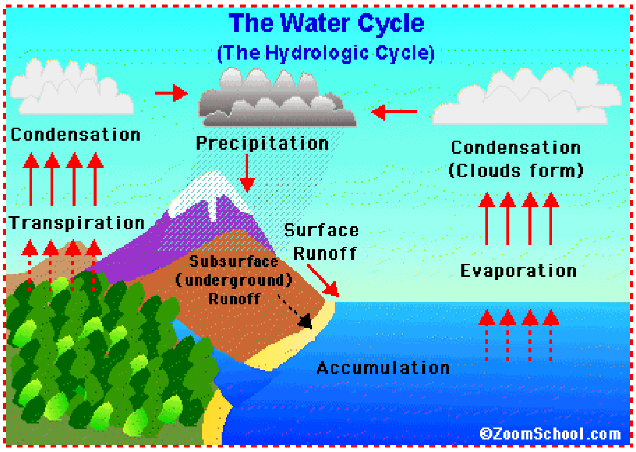

Figure 1: The Hydrological cycle (Wikipedia, 2012).

2. Geology of the Area

Ekiti State is underlain by the Precambrian rocks of the Basement Complex of Southwestern Nigeria which covers about 50% of the land surface of Nigeria (Figure 2). The Basement Complex forms part of the mobile-belt east of the West African craton and it is polycyclic. The rocks are concealed in places by a variably thick overburden. The major lithologic units according to Rahaman, (1988) are the migmatite-gneiss complex; the older granites; the charnockitic rocks; the slightly migmatised to unmigmatised paraschists and metaigneous rocks and the un-metamorphosed granitic rocks.

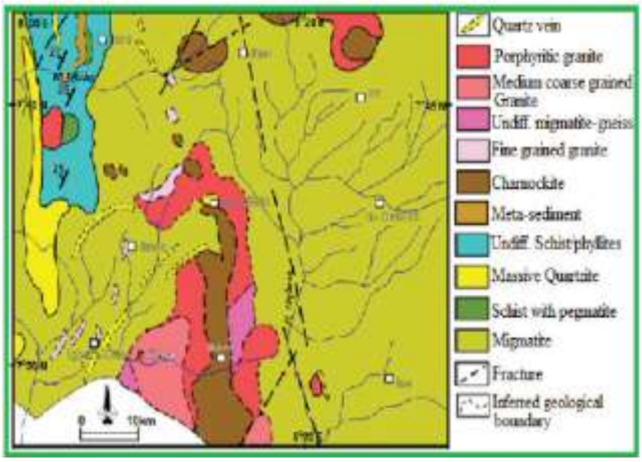

Figure 2: Geologic Map of Ekiti State (Talabi and Tijani, 2011).

2.1. Hydrogeological Settings of the Study Area

Ekiti State University, Ado-Ekiti Southwestern Nigeria is underlained by Precambrian Basement Rocks with heavy dependence on rain water, surface water and groundwater for its water supplies. In tropical and equatorial regions, weathering process creates superficial layers, with varying degrees of porosity and permeability. The unconsolidated superficial materials often constitute reliable aquifer units if significantly thick and appropriately porous and permeable. The concealed basement rock may contain faulted areas, incipient joints and fracture systems derived from tectonic events earlier experienced. The detection and delineation of these hydrogeologic structures may facilitate the location of groundwater prospect zones in a typical basement setting (Omosuyi et al., 2003). The crystalline basement rocks generally lack primary porosity and permeability. As such, secondary porosity (joints, lineaments and the weathered zone) is the main source for groundwater occurrence, movement and transmission. Groundwater occurs under unconfined conditions in shallow, moderately weathered zones and in semi-confined conditions in joints, fissures, and fractures that extend beyond the weathered zones (Olayinka and Olorunfemi, 1992; Olorunfemi et al., 1999; Adelusi et al., 2004). Increasing population with the attendant human activities geometrically leads to increasing demand for groundwater resources. The surface water, where available and accessible, cannot guarantee the required water quality status required for most domestic activities.

3. Materials and Methodology

The array used for data acquisition was the schlumberger electrode configuration. Figure 3 shows the layout of the survey carried out in the study area. Four (4) vertical electrical sounding data were acquired on a single traverse. The VES data was interpreted quantitatively by carrying out a manual partial curve matching. The curve matching involved the use of the master curve and partially matching on the auxiliary curves. After curve matching, parameters such as resistivity and depth values were generated on the bi-log graph which was inputted into the computer for modeling and iteration using RESIST for windows software.

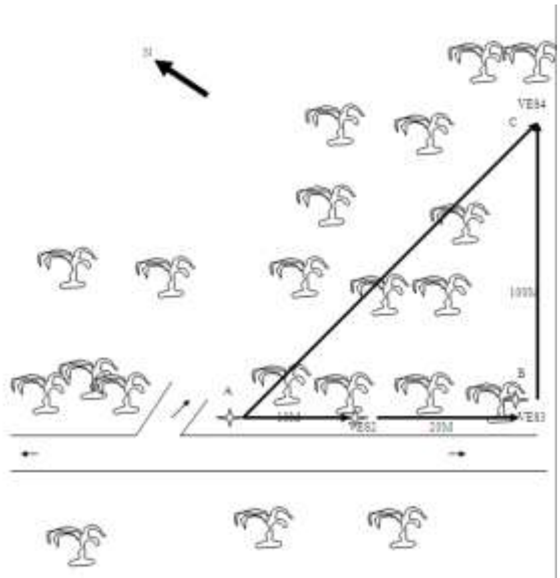

Figure 3: The Base map of Ekiti State University Showing VES Points

4. Results and Discussions

The plots of apparent resistivity against the half electrode spacing (AB/2) produced KH-Type curves (Figures 4 to 7). The topsoil directly overlay the sandy clay soil. The later serves as protection to the aquifer to avoid groundwater contamination. The resistivity value of sandy clay ranges from 605.2-700.8Ωm and the thickness of the zone ranges from 2.7-12.4 m. Underlying the Sandy Clay layer is the weathered/fractured or basement with resistivity range of 37.7-195.4 Ωm and thickness range of 10.0-19.0 m. The weathering of this layer can be due to the mineral composition of the rocks. The resistivity of the weathered layer is lower compared to the overlying rock due to increase in porosity and permeability of the layer and these properties allows accumulation of groundwater. This layer can be a major target for groundwater depending on its thickness.

The last layer underlying the weathered layer is the fresh basement which comprises of the fresh unaltered rock layer. Its resistivity ranges from 243.7-6035.7 Ωm and it is boundless. The fresh basement is not permeable and porous, this properties makes groundwater accumulation impossible in this layer. For groundwater potential evaluation, the total thickness of the material overlying the fresh basement is considered in determining how substantial the groundwater an area can contain. Figures 8 and 9 displays the two geo-electric section of the study; showing the picture of the subsurface of the study area. They also explain the resistivity, depth and thickness of each layer encountered in the course of this investigation. Table 1 summaries the results of the resistivity survey.

The four (4) VES carried out in the field of the study area (EKSU FARM) has relatively high overburden. Hence, can only sustain a pump well and not a submersible, because it will give a relatively low yield.

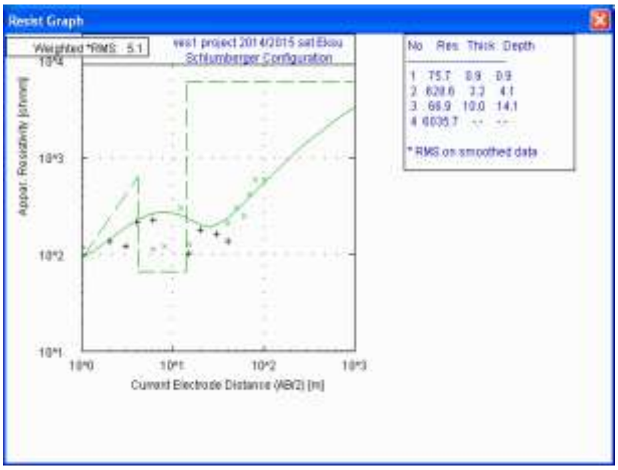

Figure 4: VES 1 Result Showing Curve type (KH).

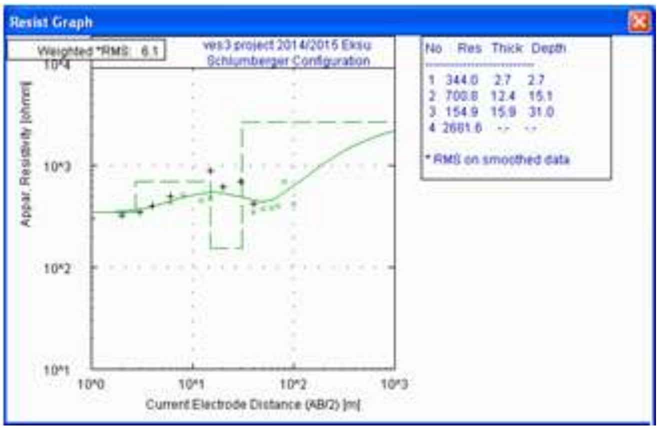

Figure 6: VES 3 Result Showing Curve type (KH)

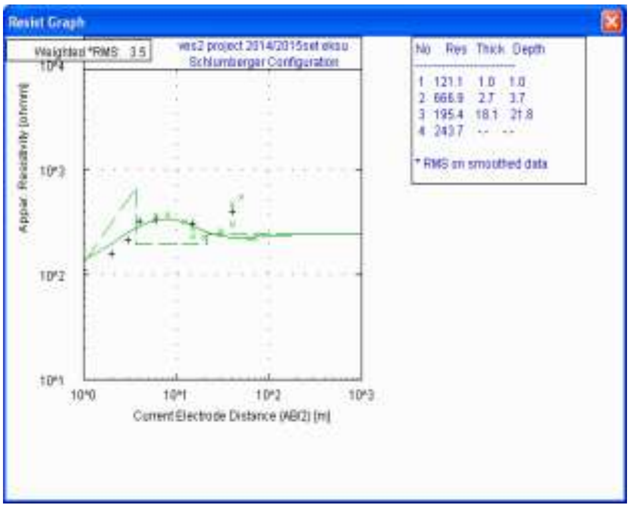

Figure 5: VES 2 Result Showing Curve type (KH)

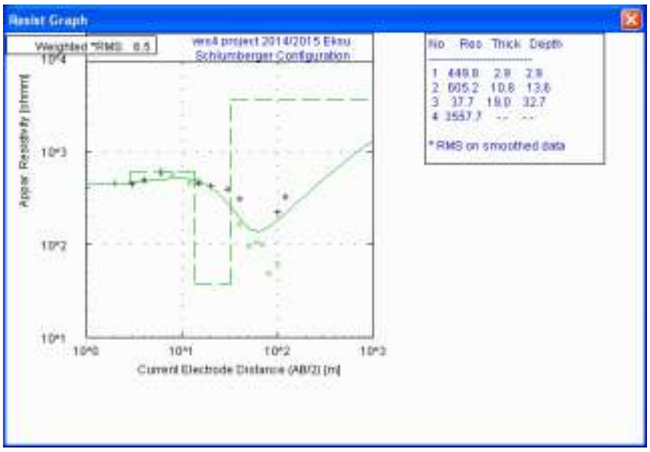

Figure 7: VES 4 Result Showing Curve type (KH).

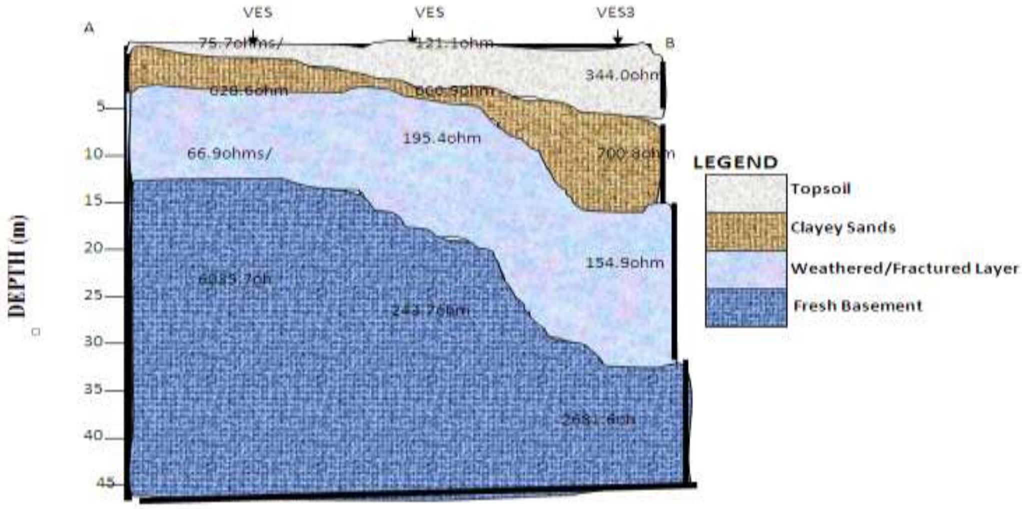

Figure 8: Geo-electric Section of VES points 1,2 and 3

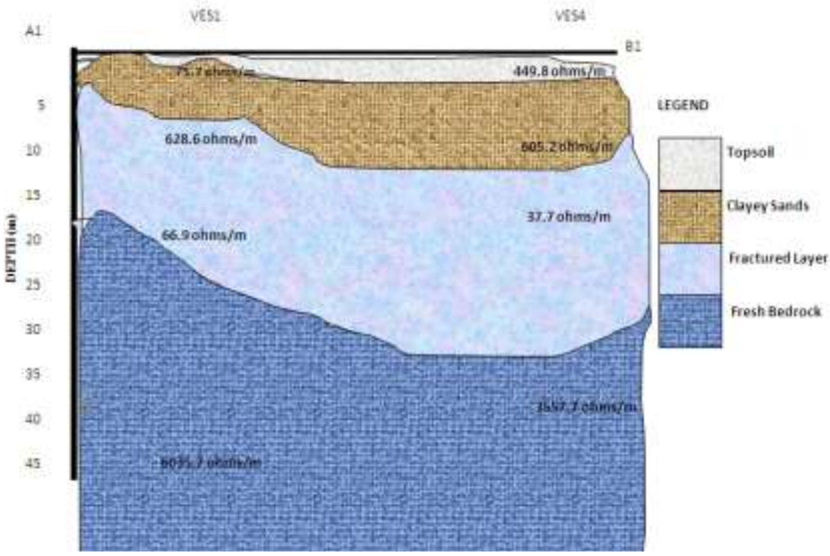

Figure 9: Geo-electric Section (VES 1 and 4)

Table 1: Summary of layer model interpretation of VES points

Station	Layer	Resistivity (ohm-m)	Thickness(m)	Depth(m)	Probable Lithology
	1	75.7	0.9	0.9	Topsoil
	2	628.6	3.2	4.1	Sandy Clay
	3	66.9	10.0	14.1	Weathered Layer
VES 1	4	6035.7	infinite	infinite	Fresh Basement
	1	121.1	1.0	1.0	Topsoil
	2	666.9	2.7	3.7	Sandy Clay
	3	195.4	18.1	21.8	Weathered Layer
VES 2	4	243.7	infinite	Infinite	Fresh Basement
	1	344.0	2.7	2.7	Topsoil
	2	700.8	12.4	15.1	Sandy Clay
	3	154.9	15.9	31.0	Weathered Layer
VES 3	4	2681.6	infinite	Infinite	Fresh Basement
	1	449.8	2.9	2.9	Topsoil
	2	605.2	10.8	13.6	Sandy Clay
	3	37.7	19.0	32.7	Weathered Layer
VES 4	4	3557.7	infinite	Infinite	Fresh Basement

5. Conclusions and Recommendations

The use of the vertical electrical sounding (VES) has tremendously safeguarded the waste of money on local means of searching for groundwater which makes this research work to Ekiti State University groundwater potential evaluation paramount as it has aided in locating points to which boreholes can be drilled within the school farm. KH sounding curves were obtained from the electrical resistivity field data. The survey delineated four subsurface geologic layers which include the top material, clay sands, partly fractured/weathered layer and fresh basement. The weathered/fractured basement constitutes the main aquifer unit. The groundwater potential is medium level rating. VES 1, VES 2 and VES 4 recommended for borehole drilling. The borehole depth should be of between 45-55 m.

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